JOURNAL OF DAIRY SCIENCE

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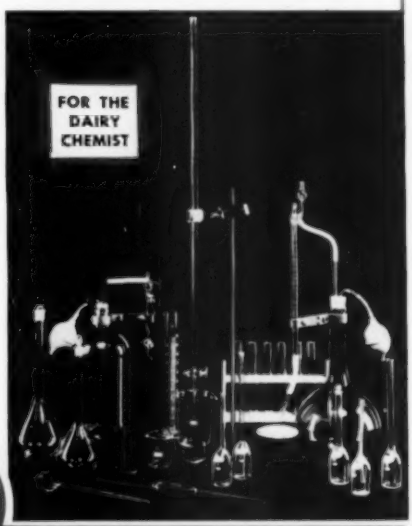

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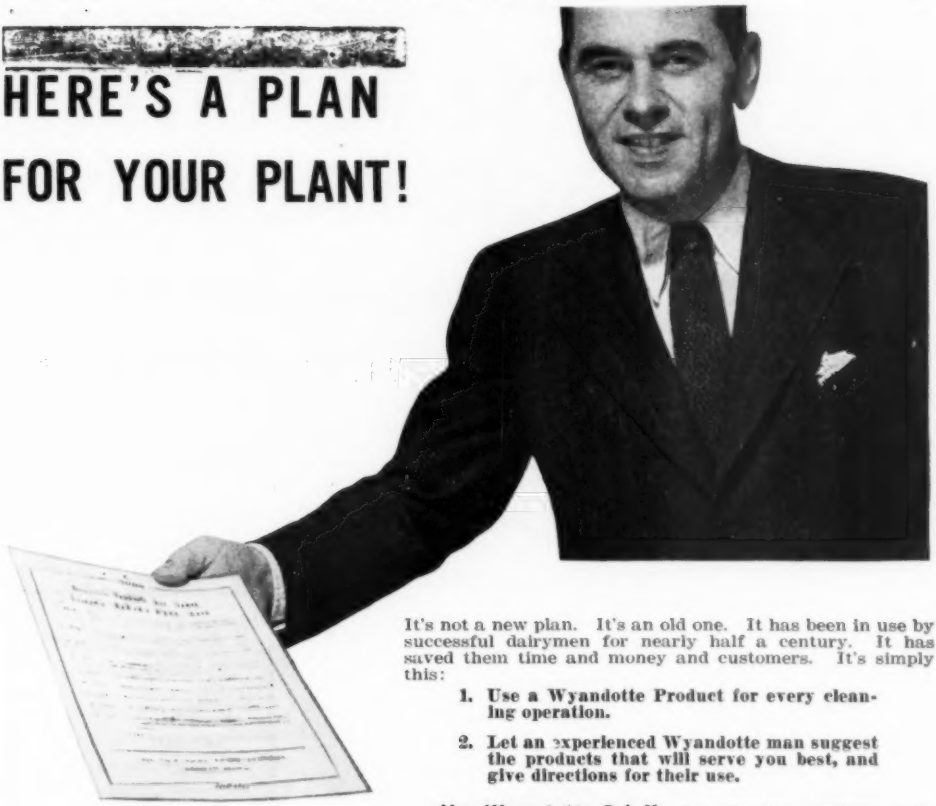

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JOURNAL OF DAIRY SCIENCE

VOLUME XXV SEPTEMBER, 1942 NUMBER 9

THE USE OF ENZYME-CONVERTED CORN SIRUP IN THE MANUFACTURE OF BULK SWEETENED CONDENSED MILK[1]

P. H. TRACY AND GEORGE EDMAN

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The use of sucrose sugar as a preservative in condensed milk has been practiced for a good many years. However, sucrose shortages that have recently developed make it advisable to consider other types of sweetening agents for preserving food products. In the period immediately following the first World War considerable progress was made in the development of methods for manufacturing refined dextrose, and in 1930 the United States Secretary of Agriculture ruled that the use of pure refined corn sugar in the preparation of an article of food need not be declared upon the label. Ramsey, Tracy and Ruehe (1), in 1933, reported that dextrose could be used to replace one-half the sucrose used in the manufacture of sweetened condensed skim milk. When all the sucrose was replaced with dextrose, mass crystallization took place. Greater tendency toward physical thickening and brown discoloration occurred when the dextrose was used, making special preheating procedures and storage conditions advisable.

The use of corn sirup in the manufacture of condensed milk has not been given serious consideration because of the low dextrose and high dextrin content of this product. Recently, however, high-conversion types of corn sirup have been developed which contain less dextrin and a much higher dextrose equivalent than the ordinary glucose sirup. This is shown by the following comparison of the analysis[2] of representative samples of these two types of corn sirup:

	High-(enzyme) converted corn sirup	Confectioners' type of corn sirup
	%	%
Moisture	18.0	19.7
Dextrose	33.0	17.6
Maltose	23.5	16.6
High sugars	6.4	16.2
Dextrins	18.8	29.6
Ash	0.3	0.3

Received for publication April 11, 1942.

[1] A portion of the thesis submitted by the junior author to the Graduate School of the University of Illinois in partial fulfillment of the requirements for the M.S. degree in Dairy Husbandry.

[2] Data supplied by the laboratory of the A. E. Staley Manufacturing Co., Decatur, Ill.

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A study was planned in which both sweetened whole and sweetened condensed skim milk were manufactured in order to study the practicability of the use of the enzyme-converted corn sirup in the manufacture of sweetened condensed milk. The present report has to do with the development of manufacturing methods. The bacteriological aspects of this study will be reported in a later publication.

METHOD OF STUDY

The batches of sweetened condensed milk were prepared in a commercial sized (36-inch) vacuum pan. The substitution of the sucrose for the high conversion corn sirup was on a dry matter basis.

Pasteurized milk was preheated in an open type hot well with live steam. The sugar was added in the first series in the hot well before preheating, but in the last two series the milk and sugar solutions were preheated separately. The condensing process was continued until the finished product contained approximately 28 per cent milk solids, 42 per cent sugar and 70 per cent total solids in the case of the sweetened skim milk. The sweetened condensed whole milk was standardized to contain 8 per cent fat, 20 per cent serum solids, and 42 per cent sugar solids.

The important variables that were introduced were 1) preheating temperature; 2) method of adding the sugar, 3) amounts and kinds of sugar added; and 4) the temperature and time of storage. These variables were used as shown in table 1.

In order to study the effect of time and temperature during storage, a number of one-half pint glass milk bottles were filled from the batches of sweetened condensed skim milk designated in the table. The bottles were disc capped, sealed with hood caps, and divided into three groups. The first group was stored at 90° F.; the second group was stored at 66° F.; and the third group was stored at 40° F.

Samples stored thus were removed at definite intervals of time and examined for color, body (viscosity), flavor and acidity, and pH.

Color determinations were first made with a K & E color analyzer manufactured by the Keuffel & Esser Company of Hoboken, New Jersey. Due to physical changes in the condensed milk during storage at the high temperature, this method showed some inconsistency in results. Therefore, it was discontinued after four weeks. Thereafter the samples were grouped according to their color as determined visually by the judges.

The viscosity or body was determined by two methods. One method was to use a pipette with the small end removed and calibrated to deliver 10 ml. Two marks were placed on the pipette with a capacity of 5 ml. between the two marks. By the use of a stopwatch the rate of flow from one mark to the other was determined, the temperature being constant at 100° F. Here again difficulty was encountered because of the high viscosity that some of

TABLE 1

Composition and heat treatment given to experimental batches

Batch No.	Sucrose	High conversion corn sirup	Preheating temperature
	Series I. Prepared March 31–April 12, 1939. Sugar preheated with the skim milk		
	%	%	°F.
A–1	42.0	0.0	170
A–2	42.0	0.0	185
A–3	42.0	0.0	200
B–1	0.0	42.0	170
C–1	21.0	21.0	170
C–2	21.0	21.0	185
C–3	21.0	21.0	200
D–1	10.5	31.5	170
D–2	10.5	31.5	185
D–3	10.5	31.5	200
	Series II. Prepared June 3–June 10, 1939. Sugar and skim milk preheated separately		
	%	%	°F.
B–1x	0.0	42.0	170
B–2x	0.0	42.0	185
C–1x	21.0	21.0	170
C–2x	21.0	21.0	185
D–1x	10.5	31.5	170
D–2x	10.5	31.5	185
	Series III. Prepared September 20–October 16, 1939. Sugar and skim milk preheated separately		
	%	%	°F.
A–1x	42.0	0.0	170
B–1x	0.0	42.0	170
C–1x	21.0	21.0	170
C–1z	21.0	*	170
C–1xW†	21.0	21.0	170

40—samples stored at 40° F.
66—samples stored at 66° F.
90—samples stored at 90° F.
* 21% dextrose.
† W = Whole milk.

the samples soon developed. The second method for determining the viscosity was the "stirring test." Wooden sticks were placed in the samples and the resistance to stirring compared. An arbitrary valuation of 3 to 15 was used for recording the relative viscosities. This method checked very well with the other method described, and it was most useful after the samples became too thick to flow.

Flavors were judged in the same manner as market milk. Scores were designated for each sample by the judges.

The titratable acidity was measured by titrating 18 grams (17.6 ml.) of sample with tenth-normal NaOH using phenolphthalein indicator. The

samples were prepared by making a 1 to 10 dilution of the sweetened condensed milk by weighing 11 grams into a 99-ml. water blank.

TABLE 2

Color changes of stored samples of condensed milk. Series I. Sugar and skim milk preheated together

Relation of preheating temperature, type of sugar used and storage temperature to the color of sweetened condensed skim milk (Samples placed in order of decreasing color each week).

0	Number of weeks stored							
	1	2	3	4	5	7	10	11
Group 1. Color—brown								
D–3–40*	D–3–90	D–3–90	D–3–90	D–3–90	D–3–90	D–3–90	D–3–90	D–3–90
	C–3–90	C–3–90	C–3–90	C–3–90	C–3–90	C–3–90	C–3–90	C–3–90
	D–3–66	D–3–66	D–3–66	B–1–90	B–1–90	B–1–90	B–1–90	B–1–90
	D–3–40	D–3–40	C–3–66	D–2–90	D–2–90	D–2–90	D–2–90	D–2–90
	C–3–66	C–3–66	D–3–40	D–1–90	D–1–90	D–1–90	D–1–90	D–1–90
			D–2–90	D–3–66	D–3–66	D–3–66	C–2–90	C–2–90
			B–1–90	D–3–40	C–2–90	C–2–90	C–1–90	C–1–90
			D–1–90	C–3–66	C–1–90	C–1–90	D–3–66	D–3–66
				C–2–90	D–3–40	D–3–40	D–3–40	D–3–40
					C–3–66	C–3–66	C–3–66	C–3–66
Group 2. Color—light brown								
C–3–40	C–3–40	C–3–40	C–3–40	C–3–40	C–3–40	C–3–40	C–3–40	C–3–40
	D–2–90	D–2–90	C–2–90	D–2–66	D–2–66	D–2–66	D–2–66	D–2–66
	B–1–90	B–1–90	D–2–66	B–1–66	B–1–66	B–1–66	B–1–66	B–1–66
	D–1–90	D–1–90	B–1–66	C–1–90	D–1–66	D–1–66	D–1–66	D–1–66
			C–1–90					
Group 3. Color—light tan								
D–2–40	C–2–90	C–2–90	D–2–40	D–2–40	C–2–66	C–2–66	C–2–66	C–2–66
	D–2–66	D–2–66	B–1–40	B–1–40	D–2–40	D–2–40	D–2–40	D–2–40
	B–1–66	B–1–66	D–1–66	D–1–66	B–1–40	B–1–40	B–1–40	B–1–40
	C–1–90	C–1–90	C–2–66	D–2–66	C–1–66	C–1–66	C–1–66	C–1–66
	C–2–66	D–2–40	C–1–66	C–1–66				
	D–2–40		D–1–40	D–1–40				
Group 4. Color—slight tan								
B–1–40	B–1–40	B–1–40	C–2–40	C–2–40	A–3–90	A–3–90	A–3–90	A–3–90
D–1–40	D–1–66	D–1–66	A–1–90	A–3–90	D–1–40	D–1–40	D–1–40	D–1–40
C–2–40	A–3–90	C–2–66	A–3–90	A–1–90	C–2–40	C–2–40	C–2–40	C–2–40
	C–1–66	C–1–66	A–3–66	A–3–66	A–1–90	A–1–90	A–1–90	A–1–90
	D–1–40	D–1–40	A–2–90	A–2–90	A–3–66	A–3–66	A–3–66	A–3–66
	C–2–40	A–3–90	A–3–40	C–1–40	A–2–90	A–2–90	A–2–90	A–2–90
		C–2–40	A–1–66	A–1–66	C–1–40	C–1–40	C–1–40	C–1–40
					A–1–66	A–1–66	A–1–66	A–1–66
Group 5. Color—normal								
C–1–40	A–3–66	A–3–66	A–2–66	A–2–66	A–3–40	A–3–40	A–3–40	A–3–40
A–3–40	C–1–40	C–1–40	C–1–40	A–3–40	A–2–66	A–2–66	A–2–66	A–2–66
A–2–40	A–2–90	A–2–90	A–2–40	A–2–40	A–2–40	A–2–40	A–2–40	A–2–40
A–1–40	A–3–40	A–3–40	A–1–40	A–1–40	A–1–40	A–1–40	A–1–40	A–1–40
	A–1–90	A–1–90						
	A–2–66	A–2–66						
	A–2–40	A–2–40						
	A–1–66	A–1–66						
	A–1–40	A–1–40						

* See key on page 767 for history of samples (table 1).

A portable Leeds & Northrup quinhydrone potentiometer was used for measuring the hydrogen-ion concentration of the samples of sweetened condensed skim milk.

EXPERIMENTAL RESULTS

In view of the large amount of data accumulated during the course of this study the experimental results to a great extent are presented in a summarized form.

Effect of Corn Sirup upon Color of Condensed Milk. As previously indicated, Ramsey *et al.* (1) found that when corn sugar was used to replace a part of the sucrose in sweetened condensed skim milk, brown discoloration took place more rapidly than when sucrose alone was used. Although the high-conversion type of corn sirup used in this study contained only about 35 per cent as much dextrose as is contained in corn sugar, it is to be expected that its use would have much the same effect upon color as does corn sugar.

Ramsey *et al.* have shown that there are several factors which may influence the degree of discoloration. The data secured in this study confirm the results of these investigators (tables 2 and 3). The darkest color occurred in the samples from batches preheated at the highest forewarming tempera-

TABLE 3

Effect of variation in time and temperature of storage upon color of sweetened condensed skim milk

(All samples contained 31.5% enzyme-converted corn sirup and 10.5% sucrose)

Order of Color*	Temperature and Time of Storage			
	57° F. Weeks†	60° F. Weeks†	63° F. Weeks†	66° F. Weeks†
1	7.0	3.5	0.5	.....
2	7.5	4.0	1.0	0.5
3	8.0	4.5	1.5	1.0
4	.....	5.0	2.0	1.5
5	9.0	5.5	2.5	2.0
6	.....	6.0	3.0	2.5
7	10.0	6.5	3.5	3.0
8	.....	7.0	4.0	3.5
9	.....	7.5	4.5	4.0
10	.....	8.0	5.0	4.5
11	.....	.....	5.5	4.5
12	.....	9.0	6.0	5.5
13	.....	.....	6.5	6.0
14	.....	10.0	7.0	6.5
15	.....	.....	7.5	7.0
16	.....	.....	8.0	7.5
17	.....	.....	.....	8.0
18	.....	.....	9.0	.....
19	.....	.....	.....	9.0
20	.....	.....	10.0	.....
21	.....	.....	.....	10.0

* Placed in order of increasing color beginning with the first sample showing discoloration at each temperature of storage. All samples on the same horizontal line had the same degree of discoloration.

† Weeks of storage.

ture. Samples containing high-conversion corn sirup developed more color during storage than did the all-sucrose samples. In all cases the changes in color were found to be greatest in the samples stored at 90° F. When the two factors (high preheating temperature and the use of high-conversion corn sirup) were combined, the condensed skim milk was dark enough in color, even when freshly made, to be detectable by eyesight.

The effect of preheating upon color was greater when the temperature was raised from 185° to 200° F. than when raised from 170° to 185° F. In other words, the critical preheating temperature as far as color change is concerned lies in the zone between 185° and 200° F. In the same way the importance of the storage temperature became significantly greater as the temperature was raised from 66° to 90° F.

Although increasing the amount of sucrose replacement with high-conversion corn sirup from 50 to 75 and 100 per cent resulted in greater tendencies towards discoloration, the differences were not marked.

These data indicate that when high-conversion corn sirup is used in the manufacture of sweetened condensed skim milk, both the preheating temperature and the temperature of storage must be properly controlled if the product is to be kept for several weeks before using.

The importance of the temperature of preheating and the storage temperature was found to decrease considerably when the milk and sugar were preheated separately. For example, when the milk and sugar were preheated together, the sample containing 42 per cent high-conversion corn sirup (B–1–66) preheated at 170° F. and stored at 66° F. for 3 weeks had a noticeable creamy color. However, when the milk and sirup were preheated separately, the sample containing 42 per cent high-conversion corn sirup (B–1x–66) preheated at 170° F. and stored at 66° F. was only slightly discolored after 12 weeks of storage. It was also observed that when the milk and sirup were heated separately, samples stored at 90° F. were the only samples considered off color after three months' storage, while in the case of the batches in which the skim milk and sirup were preheated together, some of the samples stored at 66° F. for three months became sufficiently discolored to be considered off color.

The results also show the influence of storage temperature when different types of sugar were used. Samples containing a sucrose replacement of 50 per cent dextrose, 50 per cent high-conversion corn sirup and 100 per cent high-conversion corn sirup were discolored sufficiently at the end of four weeks' storage at 90° F. to be considered off color. Even the samples containing all sucrose became highly discolored during the third month of storage.

The use of whole milk rather than skim milk did not materially effect the development of discoloration.

Table 3 shows the relation of time and temperature of storage to the

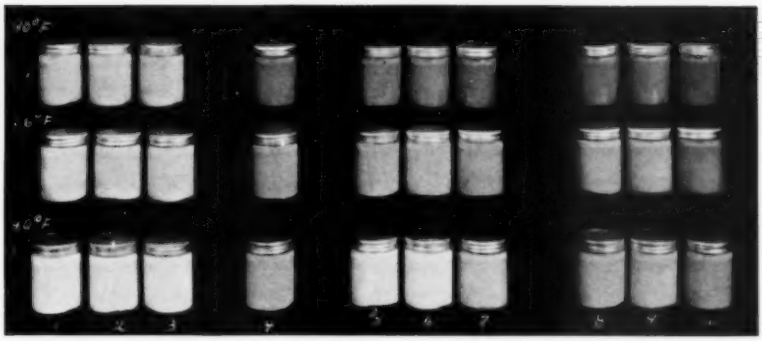

FIG. 1. Samples of sweetened condensed skim milk after storage at 40°, 66° and 90° F. for 11 weeks. Samples 1, 2, 3 contained sucrose. Samples 4 contained Sweetose. Samples 5, 6, 7 contained Sweetose (50% replacement). Samples 8, 9, 10 contained Sweetose (75% replacement). Samples 1, 4, 5, 8—forewarming temperature—170° F. Samples 2, 6, 9—forewarming temperature—185° F. Samples 3, 7, 10—forewarming temperature—200° F. In all cases milk and sugar were heated together.

FIG. 2. Samples of sweetened condensed skim milk containing different amounts of Sweetose (50, 75 and 100% replacement) after storage for 3 months at 40°, 66° and 90° F. Samples Number 1—forewarming temperature—170° F. Samples Number 2—forewarming temperature—185° F. In all cases milk and Sweetose sirup were heated separately.

TABLE 4

*Factors related to progressive thickening of sweetened condensed milk. Series 1. Sugar and skim milk heated together. Relation of preheating temperature, amount and type of sugar used, and storage temperature to the body of the sweetened condensed skim milk**

	A–1†	A–2	A–3	B–1	C–1	C–2	C–3	D–1	D–2	D–3
Stored at 40° F.										
Original	3.00	5.00	7.00	5.50	4.00	6.50	8.00	4.00	6.00	7.00
1 week	3.00	5.00	7.00	5.50	4.00	6.50	8.00	4.50	6.50	7.00
2 "	3.00	5.00	7.00	5.50	4.00	6.75	8.50	4.50	6.50	8.00
3 "	3.00	5.00	7.00	5.50	4.00	6.75	8.50	5.00	6.50	8.00
4 "	3.00	5.00	7.00	5.50	4.00	6.75	8.50	5.00	6.25	8.00
5 "	3.00	5.00	7.00	5.50	4.00	6.75	8.50	5.00	6.25	8.00
7 "	3.00	5.50	7.00	6.00	4.00	7.00	9.00	5.00	6.25	8.00
10 "	3.00	5.50	7.00	6.00	4.75	7.00	10.00	5.00	6.25	8.00
11 "	4.00	6.00	7.00	6.00	5.00	7.50	10.50	5.25	7.00	9.25
Stored at 66° F.										
1 week	3.50	5.50	8.50	6.50	5.00	7.25	9.25	5.50	7.50	8.75
2 "	4.50	5.75	8.50	6.50	5.00	7.50	10.00	5.50	8.25	9.50
3 "	4.50	6.50	9.00	7.00	5.25	8.00	10.75	6.00	8.25	10.25
4 "	5.00	7.00	10.00	7.50	5.50	8.25	11.25	6.50	9.50	11.00
5 "	5.25	7.25	10.00	8.25	5.75	8.50	12.00	7.00	9.75	11.50
7 "	6.00	7.75	10.50	9.00	6.25	9.25	12.25	7.50	10.50	11.75
10 "	6.25	8.00	10.50	9.50	6.50	10.00	13.00	8.00	11.00	12.25
11 "	6.75	8.75	11.00	10.50	7.00	11.00	14.00	9.25	11.25	12.50
Stored at 90° F.										
1 week	4.00	6.50	9.00	7.50	6.00	8.00	9.75	6.50	8.50	9.25
2 "	5.00	7.25	9.00	9.75	7.25	10.00	11.00	8.25	10.50	10.50
3 "	6.00	8.00	9.50	10.50	7.00	10.75	12.00	9.50	11.00	11.25
4 "	7.00	8.00	10.00	11.00	7.50	11.25	12.50	10.50	12.00	12.25
5 "	7.50	9.50	11.00	11.75	8.50	12.25	13.00	11.00	12.25	12.75
7 "	8.00	10.00	11.25	12.00	8.75	12.50	13.25	11.25	12.50	13.00
10 "	8.25	10.50	11.75	12.50	10.00	13.25	14.00	12.00	13.25	13.50
11 "	9.00	11.50	12.50	13.00	11.00	13.50	14.50	13.00	13.50	13.75

* The higher the viscosity value the more plastic the mass.

† See key to data on page 767 for history of samples (table 1).

degree of discoloration. Samples of sweetened condensed skim milk containing 10.5 per cent sucrose and 31.5 per cent high-conversion corn sirup were placed in test tubes and incubated at 57°, 60°, 63°, and 66° F. The temperatures of the incubators did not vary more than ± 0.5°. The data show that when a storage temperature of 57° F. was used, it was not until the seventh week that a perceptible change in color occurred. When the samples were stored at 60° F. a change in color was noted after 3.5 weeks, while at 63° F. and 66° F. there was a change in color of the samples after ½ week. It should be noted that the samples stored at 57° F. for 9 weeks had the same degree of discoloration as those stored at 60° F. for 5.5 weeks, 63° F. for 2.5 weeks, and 66° F. for 2 weeks. The discoloration of samples stored at 66° F. for 10 weeks, however, was not sufficient to make the condensed milk unsalable.

Progressive Thickening. The relation of the preheating temperature, the type of sugar used, and the storage temperature to progressive thickening was determined. Preheating temperature had a noticeable effect, the highest temperature causing the greatest increase in viscosity. The all-sucrose samples exhibited less change in body during storage than did any of the samples containing high-conversion corn sirup (table 4). All the samples stored at 40° F. increased in viscosity very slowly, many remaining almost the same for the entire storage period of 11 weeks. However, when the samples were stored at 66° F. the viscosity increased rapidly, particularly in the case of the samples from batches preheated at 200° F. The samples stored at 90° F. thickened most rapidly.

Data from series II show the relation of preheating and storage temperatures to the progressive thickening of sweetened condensed skim milk containing varying amounts of high-conversion corn sirup when the skim milk and sugar were preheated separately. Both factors—preheating temperature and storage temperature—were found to have less effect on the body when the skim milk and sugar were preheated separately than when heated together.

The relation of storage temperature to the progressive thickening of sweetened condensed skim milk samples containing three different types of sugars was also determined (Series III). In this series the sugar (or sirup) and milk were preheated separately at 170° F. The all-sucrose samples were found to be the least affected by progressive thickening. The dextrose samples ranked next to the all-sucrose samples in this respect. The samples containing high-conversion corn sirup were more viscous than either the dextrose or sucrose samples. It is possible that the higher viscosity of the samples containing high-conversion corn sirup was partly due to the dextrin present in the corn sirup.

In the third series, the data also show that the sweetened condensed milk prepared from whole milk thickened less than did the skim milk product.

TABLE 5

Changes in hydrogen ion concentration in stored condensed milk. Series I. Sugar and skim milk preheated together. Relation of storage temperature to changes in pH of sweetened condensed skim milk*

	A–1†	A–2	A–3	B–1	C–1	C–2	C–3	D–1	D–2	D–3
Samples stored at 40° F.										
Original	6.07	6.10	6.12	5.96	6.07	6.10	6.07	6.10	5.93	5.96
4 weeks	6.08	6.21	6.25	5.94	6.04	6.06	6.04	6.06	6.08	6.08
7 "	6.05	6.17	6.22	Broken	6.00	6.02	5.99	6.02	6.00	6.04
11 "	6.12	6.26	6.33	5.95	6.09	6.11	6.07	6.07	6.07	6.17
Ave.	6.08	6.185	6.23	5.95	6.05	6.048	6.04	6.06	6.02	6.06
Samples stored at 66° F.										
4 weeks	6.28	6.31	6.35	6.04	6.21	6.21	6.14	6.19	6.19	6.23
7 "	6.21	6.26	6.31	6.02	6.19	6.21	6.14	6.16	6.17	6.19
11 "	6.31	6.36	6.39	6.12	6.24	6.26	6.19	6.21	6.23	6.24
Ave.	6.26	6.31	6.35	6.06	6.21	6.22	6.15	6.18	6.19	6.22
Samples stored at 90° F.										
4 weeks	6.31	6.34	6.38	6.05	6.22	6.21	6.14	6.21	6.21	6.21
7 "	6.29	6.27	6.34	6.07	6.21	6.17	6.12	6.14	6.16	6.16
11 "	6.45	6.46	6.48	6.19	6.33	6.33	6.28	6.29	6.31	6.28
Ave.	6.35	6.35	6.40	6.10	6.25	6.23	6.18	6.213	6.22	6.216

* pH determined on undiluted samples.

† See key to data on page 767 for history of samples (table 1).

The greatest difference in the bodies of these two products occurred in those samples stored at 90° F.

One interesting observation noted in the third series was the greater degree of progressive thickening of the samples containing 50 per cent of the sucrose replaced with high-conversion corn sirup as compared to either the 75 per cent or 100 per cent high-conversion corn sirup replacement. This was true regardless of the preheating temperature.

Flavor. There were some changes in flavor scores of all the samples during the storage period. In series I the least change occurred in the samples stored at 40° F., while the greatest changes in flavor were in those samples stored at 90° F. The higher the preheating temperatures the lower the initial scores and the fewer changes there were in the flavors during storage. The samples containing high-conversion corn sirup likewise showed less reduction in flavor scores than did the sucrose samples, although the initial scores of the all-sucrose samples were higher. The high-conversion corn sirup samples were scored down somewhat because of a slight bitterness due in part, probably, to the lesser degree of sweetness.

In series II the relation of preheating temperature and storage temperature to the flavor of sweetened condensed skim milk containing 50, 75, and 100 per cent high-conversion corn sirup replacements was found to be essentially the same as in series I. However, when the skim milk and sugar were heated separately as in the second series, there was less change in flavor scores during storage. These data indicate that the best flavor can be obtained by preheating the skim milk and sugar separately.

Samples of sweetened condensed skim milk containing different types of sugars after being stored for three months ranked in flavor in descending order as follows: 1) 50 per cent of the sucrose replaced with dextrose, 2) 50 per cent of the sucrose replaced with high-conversion corn sirup, 3) 42 per cent high-conversion corn sirup, and 4) 42 per cent sucrose. This ranking was the same regardless of the temperature of storage. In fairness to the all-sucrose sample it should be mentioned that this sample was somewhat abnormal due to a separation of lactose crystals.

After four weeks of storage the flavor of the sweetened condensed milk made from skim milk was found to be much better than that of the product made from whole milk. The reason for the lower flavor score of the sweetened condensed whole milk product was the development of an oxidized flavor.

pH of Sweetened Condensed Milk. When the sugar and skim milk were preheated together the samples containing all-sucrose had a higher pH when the preheating temperature, storage temperature, and storage period were increased (table 5). The samples containing all-sucrose had a higher pH than the samples in which a part or all of the sucrose had been replaced with high-conversion corn sirup. This effect of the high-conversion corn sirup is to be expected since the sirup has a pH of 4.8 to 5.0.

Samples containing high-conversion corn sirup increased in pH when the

storage temperature was increased, but increasing the preheating temperature and storage period did not cause the pH to change to the same degree as in the case of the all-sucrose samples.

When the sugar and skim milk were preheated separately, and when 50, 75, and 100 per cent of the sucrose was replaced with high-conversion corn sirup, increasing the preheating temperature and increasing the storage temperature from 40° F. to 66° F. resulted in an increased pH. On the other hand, the samples stored at 90° F. had a lower pH. Increasing the storage period also caused the pH of the samples to decrease. The decrease was not sufficient, however, to indicate bacterial spoilage of any consequence.

Data from series III show that samples containing all-sucrose had a higher pH than those containing either high-conversion corn sirup or dextrose.

Sweetened condensed milk samples made from whole milk had a higher pH than the samples made from skim milk. This is to be expected because of the higher serum solids content of the latter product.

SUMMARY

The use of enzyme-converted corn sirup to the extent of 50 to 100 per cent replacement of the sucrose in the manufacture of bulk sweetened condensed skimmed and whole milk has been found practicable. Best results from the standpoint of color and physical thickening were obtained when the milk and sirup were heated separately and when the preheating temperature was limited to 185° F. There was less physical thickening and less brown discoloration when the samples were stored at low temperatures. For commercial operations the storage temperature need not be lower than 60° F. unless the condensed milk is to be held for more than three months. At 90° F. the change in color and body takes place rapidly. Judging from the flavors and pH measurements, samples of condensed milks sweetened with high-conversion corn sirup (50 to 100 per cent replacement) have normal keeping qualities.

The procedure recommended for the use of high-conversion corn sirup is as follows:

1. Replace 50 to 100 per cent of the sucrose with the corn sirup.
2. Preheat milk to 185° F.
3. If a minimum viscosity and color effect is desired, preheat milk and sirup separately, drawing sirup into the vacuum pan near the end of the run.
4. Store the condensed milk at as low temperatures (60° F. or less) as convenient unless it is to be used within a few days after manufacture.

ACKNOWLEDGMENT

The high-conversion corn sirup used in this study was supplied by the A. E. Staley Manufacturing Company, Decatur, Illinois.

REFERENCE

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ORTHOPHOSPHORIC ACID AS A CHEESE SOLVENT

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The possibility of using a weak solution of orthophosphoric acid as a solvent for cheese curd in determining extraneous matter in cheese was studied by us. Preliminary trials showed that a boiling 1.0 per cent aqueous solution of phosphoric acid was capable of dissolving Swiss, American, Limburger, cottage, Romano and process cheese, including their rinds.

Observations were made on the action of the 1.0 per cent phosphoric acid solution on some of the cellulose, chitin, and inorganic types of extraneous matter occasionally found in cheese. These types of extraneous matter lost approximately 5 per cent of their weight during 20 minutes of boiling in 1.0 per cent phosphoric acid. Their structures were not visibly impaired.

A large series of extraneous matter determinations on green and aged cheeses shows that 50 grams of cheese dissolves readily in 500 ml. of 1.0 per cent phosphoric acid. It appears likely that 50 grams of cheese would be a satisfactory amount of cheese to use since this would be comparable to the amount of milk solids in the pint of milk used in the milk sediment test. However, if a larger sample needs to be examined for sediment it is only necessary to use a correspondingly larger amount of phosphoric acid solution to dissolve it. The following method was adopted for removing the extraneous matter from cheese for examination and scoring.

APPARATUS

1. One cheese trier.
2. One food grater with $\frac{1}{8}''$ holes.
3. A 1-liter beaker.
4. One pressure milk sediment tester.
5. Milk sediment pads.
6. Irish poplin cloth pads of the same size as the milk sediment pads.[1]
7. One 500-ml. graduate.
8. One 5-ml. graduate.
9. One glass stirring rod.
10. One hot plate or gas burner and tripod.

REAGENTS

1. An aqueous solution containing 1.0 per cent by weight of orthophosphoric acid. This is made by adding 7 ml. of orthophosphoric acid to 1000 ml. of water.
2. Acetone.[1]

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[1] Suggested by R. E. Miersch and Dr. W. V. Price, University of Wisconsin Dairy Department, Madison, Wisconsin.

PREPARATION OF SAMPLE

Take a sample of cheese by plugging the cheese to be examined two or three times with the cheese trier. Grate the cheese plugs on the cheese grater, being careful to exclude all outside contamination.

DETERMINATION

Weigh 50 grams of the grated cheese into a clean 1-liter beaker and add to it 500 ml. of 1.0 per cent phosphoric acid. Heat to boiling, stirring occasionally to prevent cheese from sticking to the bottom of the beaker. Boil until all the cheese is dissolved and filter immediately through the pressure milk sediment tester with the poplin cloth pad on top of the milk sediment pad. Wash the beaker and tester with distilled water, forcing the wash water through the filter pads. Remove the pads carefully and examine the extraneous matter on the surface of the poplin cloth pad. The moisture remaining in the sediment pad can be removed by rinsing the pad with 5 ml. of acetone before it is taken from the sediment tester.

GRAZING HABITS OF DAIRY CATTLE

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Maximum returns from any pasture depend upon cropping practices conducive to growth response of plants, and upon cattle management to avoid waste. The inter-relationship of these two primary factors and the need for proper balance between the two in pasture management are apparent. Combination of rotational grazing with clipping, fertilizing, etc., are typical attempts to consider both major factors. Many conditions influence the system of cattle management adopted, such as short time pasturage daily to make limited pasture go further, night pastures, etc. Grazing habits of cows are of interest from the standpoint of the wellbeing of both the cattle and the pasture.

GRAZING HABITS OF MILKING COWS DURING DAYTIME

Comparative time spent in grazing by milking cows on six different pastures was recorded. Two cows were used on each pasture. The pastures averaged about four acres. Observations were taken for three consecutive days on each pasture, but not concurrently. The observations covered a 12-hour daylight period for the first two days and 11 hours the third day, or an average of 11 hours and 40 minutes per day. Records were kept on the time spent in grazing, number of times each cow lay down, and the number of times each cow drank.

Summarization of results (table 1) showed the cows spent slightly less than half the time in grazing while on good pasture. Four different pairs of cows on four different good pastures averaged practically the same time spent in grazing, the variation being from 46 per cent of the day to 50 per cent, or a maximum difference between the groups of only 20 minutes in approximately five and one-half hours. One pair of cows was pastured on a field of mixed brome grass and alfalfa which was not uniform in stand. It was rated as *fair* pasture because it appeared to have less feed on it than the better pastures. Another field rated as *poor* pasture consisted of short wheat. On the fair pasture the cows spent 56 per cent of the time grazing and on the poor pasture 62 per cent of the time. Compared with an average of 5.6 hours of grazing on the four good pastures, the grazing time on fair pasture was 6.5 hours and 7.3 hours on poor pasture. Thus the cows spent 31 per cent more time grazing on the poor pasture than the average on the good pastures. Whether this difference would have been even more pro-

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TABLE 1

Grazing habits of dairy cows on several pastures—daytime only

No. cows	Kind of pasture			No. in trials		Av. time grazing		Ave. No. drinks	Av. time not grazing		Ave. No. times lying down	Ave. total daily hrs.
	Height inches	Variety	Quality	Days	Cows	Hrs.	Per cent		Hrs.	Per cent		
2	4–15	Rye	Good	3	2	5.4	46	3	6.3	54	6	11.7
2	4–15	Rye	Good	3	2	5.4	46	3	6.3	54	3	11.7
2	4–15	Rye & vetch	Good	3	2	5.7	49	4	6.0	51	3	11.7
4	4–12	Brome & alfalfa	Good	3	4	5.8	50	4	5.9	50	4	11.7
4	4–10	Brome & alfalfa	Fair	3	4	6.5	56	4	5.2	44	2	11.7
2	2– 3	Wheat	Poor	3	2	7.3	62	4	4.4	38	2	11.7

nounced had the cows been on the pastures constantly with no supplementary feed is not known.

While on pasture the cows drank an average of from three to four times during the day with no apparent relationship to quality of pasture. This would indicate the importance of having water readily available in the pastures for milking cows. The cows lay down an average of four times daily on good pastures and only two times daily on fair and poor pastures. This indicates that the cows had more difficulty getting their fill of grass, but whether there is any relationship with the time spent in ruminating in proportion to the amount of feed ingested, or in utilization of feed is unknown.

GRAZING HABITS OF DRY COWS AND HEIFERS CONTINUOUSLY ON PASTURE

A more complete study of grazing habits of dairy cattle was made with a group of 56 dry cows and yearling heifers being pastured on a 30 acre field of Balbo rye (3). The pasture was excellent, the herbage being 6 to 10 inches high. The animals remained on the pasture constantly and received no supplementary feed. The animals were kept under constant watch and the numbers grazing, not grazing, and lying down were recorded at five minute intervals for three consecutive 24-hour periods. A heavy rain for several hours interrupted observations on one day. A period (April 10–14, 1940) was selected when the moon was about half full in order that night counts could be made without distracting the cows with a light.

TABLE 2

Grazing habits of dry cows and heifers continuously on pasture

	Grazing		Standing		Lying down	
	Hrs.	Per cent	Hrs.	Per cent	Hrs.	Per cent
	Twelve-hour day and night					
Daytime	4.3	36	2.8	23	4.9	41
Nighttime	2.7	23	1.2	10	8.1	67
24-hr. ave. total	7.0	29	4.0	17	13.0	54
	Fourteen-hour day and ten-hour night					
Daytime	5.6	40	3.5	25	4.9	35
Nighttime	1.6	16	0.4	4	8.0	80

Summarization of the results (table 2) showed that the animals grazed an average of 7.0 hours, or 29 per cent of a 24-hour period. The animals spent an average of 4.0 hours, or 17 per cent of the time in walking or standing without grazing, and 13.0 hours, or 54 per cent of the 24-hour periods in lying down. When the 24-hour period was divided into two 12-hour periods, 6:00 A.M. to 6:00 P.M. for daytime and the similar hours for night,

the time the animals spent in grazing averaged 4.3 hours, or 36 per cent of the day period; and 2.7 hours, or 23 per cent of the night period. Since the sun rose at 6:00 A.M. and set at 7:00 P.M. during the trials, a 14-hour daylight period of from 6:00 A.M. to 8:00 P.M. inclusive would be a more typical daylight feeding period and 8:00 P.M. to 6:00 A.M. would more nearly represent night conditions. Comparisons of the grazing habits of the animals on an average 14-hour day and 10-hour night showed that they grazed 40 per cent of the time in daytime and 16 per cent of the time at night. They spent 25 per cent of the daytime and only 4 per cent of the night walking or standing. The animals were lying down 35 per cent of the daytime and 80 per cent of the night.

The average of 7 hours in 24 spent in grazing is in reasonable agreement with the report of 8 hours found by Johnstone-Wallace (2), with milking cows on different types of pastures. His report that cows spend as much time grazing at night as in the daytime is not supported by the results of this investigation. The time spent in grazing during the day time of this trial (29 per cent) is less than reported for milking cows (46–62 per cent) in table 1, but the differences in pasture, the effect of pasturing during daytime only, and the differences between milking cows and dry cows may account for longer grazing periods in the former trial. The fact that these 56 animals averaged 54 per cent of the 24-hour periods lying down is in agreement with the reports of Fuller (1) who found that cows fed in stanchions during winter averaged 50 per cent of the time lying down. He also reported that the cows spent an average of 5.95 hours eating, or 25 per cent of the 24-hour period; and 8.1 hours ruminating, or 34 per cent of the time. Woodward (4) reported that cows on good pastures consumed a maximum of 150 pounds of grass daily. From these facts it would seem cows on poor pastures not only must spend more energy in obtaining sufficient food but that the normal time spent in ruminating may be involved.

Detailed study (fig. 1) of the grazing habits of the cows showed that the animals tended to have about four primary grazing periods during the daytime. The first period began about 5:30 A.M. and lasted approximately two and one-half hours. Another feeding period began about 10:00 A.M., or slightly before, and lasted from an hour to an hour and a half. The third feeding period began between 12:30 and 1:00 o'clock and continued for about two hours. The fourth daylight grazing period began about 6:00 P.M. and continued until about 8:30 P.M.

The night period was considered between 8:30 P.M. and 5:00 A.M. During the night the cows had two primary feeding periods, one from about 9:30 P.M. to 11:00 P.M. and another from about 1:00 A.M. to 3:30 A.M. Thus, it appeared that the animals as a group tended to fill about six times in 24 hours, four times during daylight and twice during the night. In the daytime the entire herd tended to graze as a complete unit or lie down as a

group, but at night the lower peaks in grazing numbers with periods less sharply defined indicated more individual action by the animals.

These observations are of interest in pasture management because the cows tend to graze less in night pastures than in daytime pastures. It is also interesting to note that the herd does not fill before the time when the average herd is brought into the barn for the morning milking. This would

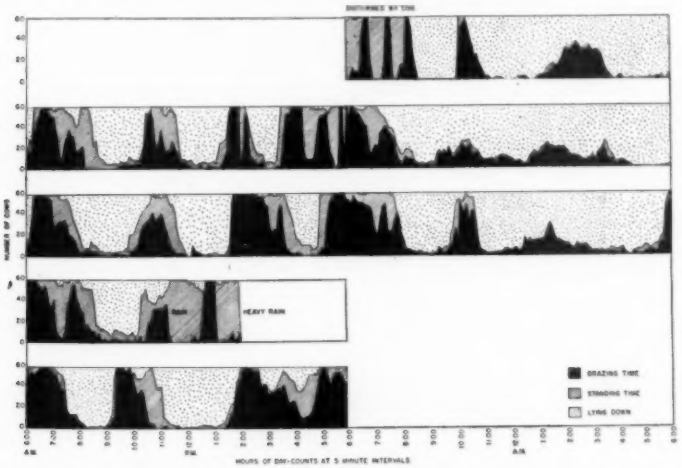

FIG. 1. Observations on 56 dry cows and heifers continuously on pasture, with the number grazing, standing and lying down indicated throughout 24-hour periods.

indicate that in summer management of cows earlier milking might be desirable if the cows are to get a complete fill after milking before the flies and heat interfere with grazing habits. These data were obtained in April when the climate was ideal for cow comfort. What effect heat and flies during mid-summer days would have on grazing habits is not known.

SUMMARY AND CONCLUSIONS

Comparative time spent in grazing by milking cows on six different pastures during the daytime was recorded. On good pasture the cows spent slightly less than half the time in grazing. On fair pasture the cows spent 55 per cent of the time grazing and on poor pasture 62 per cent of the time. Compared with an average of 5.6 hours of grazing on good pastures, the grazing time on fair pasture was 6.5 hours and 7.3 hours on poor pasture. Thus, the cows spent 31 per cent more time in grazing on poor pasture than on good pasture. The cows drank an average of from three to four times during the day with no apparent relationship to quality of pasture. The cows lay down an average of four times daily on good pasture and only two times daily on fair and poor pasture.

A more detailed study of 56 dairy cattle on Balbo rye pasture constantly with no supplementary feed showed that the animals spent an average of 7 hours grazing, 4 hours standing or walking, and 13 hours lying down during a 24-hour period. Comparison of a daylight period of 14 hours with a night period of 10 hours showed that the animals grazed an average of 40 per cent of the time during the day and 16 per cent during the night. They spent 25 per cent of the time walking or standing during the day, and 4 per cent during the night. The animals were lying down 35 per cent of the daytime and 80 per cent of the night.

The grazing habits of the animals from day to day were quite uniform. They had four primary grazing periods during the day and two during the night, but the night grazing periods were not so pronounced as a group as were those in the daytime.

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FACTORS MODIFYING THE RATE OF FERMENTATION OF RUMEN INGESTA AND THEIR POSSIBLE RELATION TO BLOAT IN DAIRY CATTLE*

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Fermentation of the rumen contents is essential for the normal digestion of fiber-containing feeds. Enormous changes regularly occur in the environment of the bacteria responsible for this fermentation. The ingestion of water in varying amounts and temperature, and the consumption of feed varying from zero to thirty per cent in fiber as well as in sugar content are factors to be dealt with at a moment's notice. Apparent lack of palatability of a feed might simply be an outward indication of depressed fermentation in the rumen as a result of adverse environmental conditions.

Although no extensive study has been made of the organisms responsible for the fermentation in the rumen, many gas producing organisms, such as *Bact. coli*, have been isolated from the rumen contents (5, 15). The optimum pH for growth of *Bact. coli* and many similar organisms is around pH 7.0 or a little above (10, p. 223). Studies have shown that the acidity of the rumen contents varies from pH 5.5 to 7.7 (4, 6, 9, 12). The hourly fluctuations depend largely on: the chemical composition of the feed, the amount of organic acids produced by the bacteria, and the neutralizing effect of the saliva (saliva has a pH of about 8.1) being secreted. Fresh green feeds apparently increase the rate of fermentation and decrease the amount of saliva required for mastication with the result that the pH of the rumen contents drops (6). Dry feeds, especially roughages, result in a higher pH of the rumen contents (15).

Since the optimum temperature for growth by many types of bacteria is between 37° and 45° C. (10, p. 222) it is quite probable that the changes in temperature occurring in the rumen do not seriously modify fermentation. One would expect the ingestion of large quantities of cold water only temporarily to influence the temperature of the rumen.

Dilution of the rumen contents with water affects the osmotic force of the milieu as well as the concentration of the soluble nutrients upon which the bacteria subsist. Dilution of the food supply probably affects bacteria less than dilution of their own metabolic products (10, p. 222). Growing bacteria not only are rapidly consuming oxidizable materials like glucose but they are also eliminating metabolic products which may seriously interfere with their own growth. Some of these decomposition products resulting

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from bacterial fermentation are: acetic, lactic and butyric acids, alcohol, ammonia, indol, skatol, hydrogen sulfide and mercaptans.

Analyses have shown that carbon dioxide and methane are the principal gases resulting from fermentation in the rumen (1, 3, 7, 11, 13) although hydrogen, hydrogen sulfide, carbon monoxide and other gases have been identified. Nitrogen and oxygen are also present as a contamination from the outside air. Washburn and Brody (13) found that the per cent of CO_2 increased rapidly after feeding. On a grass diet the peak was reached much more quickly than when alfalfa hay or alfalfa hay and grain were fed. The relative amount of CO_2 in the rumen gas varied from 80 per cent shortly after grass was fed to 10 per cent, twenty-three hours later. The per cent of CH_4 for the same periods were 20 and 9 respectively. Contamination with air apparently caused these marked decreases as the percentage of nitrogen and oxygen present rose from zero in both cases to 68 and 13 per cent respectively. (Analyses were for CO_2, CH_4, O_2, H_2, and N_2 only.) By measuring the amount of methane in the expired air and calculating from the above ratios the per cent of CO_2 due to fermentation, it was found that a dry cow shortly after being fed 4.5 kilos of grass (dry matter basis) produced carbon dioxide and methane at the rate of 32 and 10 liters, respectively, per hour. Five hours later the rates had dropped to 13 and 6 liters per hour and 22 hours later the rates were 1.5 and 1.2 liters per hour. It is interesting to find that on dry hay or on hay and grain the rate of methane production was almost the same as the figures just cited although the dry matter intake was only half as large. However, the rate of production of carbon dioxide was about two-thirds as large under these conditions. Data on lactating cows show a maximum rate of production of methane of 16 liters per hour shortly after feeding (for the same sized animal—about 900 lbs.). The feed intake was not given.

Although the amount of oxygen present in the gas in the rumen is relatively small (zero to three per cent) the majority of bacteria (like *Bact. coli*) are facultative or obligatory anaerobes and do not require free oxygen. The solubility of oxygen in water is so low that, were it not for the constant agitation of the rumen contents and the fact that much of the contents are out of water a large part of the time, it would appear improbable that strictly aerobic bacteria would even survive and grow in the rumen.

A wide variety of products serve as a source of feed for the bacteria in the rumen because bacteria secrete innumerable kinds of enzymes (2). Glucose and ammonium chloride are about the simplest sources of carbon and nitrogen for bacteria. Since the cow's ration doubtless always contains thousands of different compounds, either real or potential, it is not surprising if the usual changes in diet which take place on the farm only moderately influence bacterial fermentation in the paunch.

Chief among the substances normally providing energy for anaerobic

life are carbohydrates. Sugars, especially glucose, greatly increase growth under anaerobic conditions (10, p. 52, 199). It should also be noted that anaerobic fermentation is exothermic and doubtless helps provide the heat for warming the water or other cold feed ingested by the cow.

When considerable fermentation does occur, as indicated by excessive gas production, we speak of it as bloat or tympanites. This rarely occurs except when the cow is turned onto legume pasture (7, 8, 14). Although many analyses have been run on the principal constituents of legumes and non-legumes, no essential product for bacterial metabolism has ever been isolated from legumes which is not present in non-legumes. Hence there is no ready clue for determining why cows frequently bloat on legume pasture and not on non-legume pasture.

The experiments reported in this study were carried out *in vitro* on rumen ingesta obtained from a three-year-old Jersey cow with a rumen fistula. At first the cow received a ration containing a grain mixture, alfalfa hay and corn silage. The silage was later omitted. In the spring, bluegrass pasture was substituted for the alfalfa hay.

In every case the rumen ingesta were removed just previous to their use. Since the experimental procedure required 1200 grams of ingesta, a somewhat larger quantity was removed and thoroughly mixed before being placed in the fermentation apparatus. Because conditions in the rumen are constantly changing, control samples were included with each trial. In the tables which are presented, "Experimental Sample No. 1" should be compared with "Check Sample No. 1," *et cetera.*

The apparatus for gas-volume study consisted of six units. The ingesta for each unit were placed in a 500-cc. Erlenmeyer flask, which was in turn connected with a gas-collecting tube. Two hundred grams of ingesta were placed in each flask unless otherwise noted. The gas-collecting apparatus consisted of 6 pyrex tubes 48 mm. in diameter and one meter in length. These tubes were filled with a solution containing 235 gm. of NaCl and 5 cc. of lactic acid per liter of water. Previous to each experiment, carbon dioxide was bubbled through the solution to insure saturation.

The water bath in which the samples of ingesta were fermented was held at 38.5° C. except for studies of the influence of temperature on fermentation. Gas volume readings were taken at intervals of 1, 2, 3, 4, 5 and 20 hours after each trial was started. By using a leveling bulb direct readings could be made from the gas-collecting tubes. No corrections were made for changes in temperature because check and experimental tubes were exposed to identical conditions. However, an effort was always made to keep the room temperature constant.

The hydrogen-ion concentrations of the materials under study were determined electrometrically, using a quinhydrone electrode. The readings were usually taken both before and after fermentation so that changes due to treatment could be noted.

RESULTS

The data in table 1 (see also fig. 1) serve to illustrate the general trend in rate of gas formation when rumen ingesta are fermented *in vitro*. The results obtained with the two rations show the reduction in rate of fermenta-

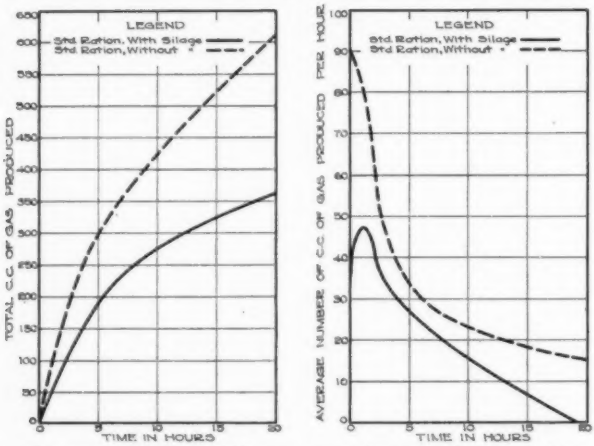
LEGEND
Std Ration, With Silage
Std Ration, Without
TOTAL C.C. OF GAS PRODUCED
TIME IN HOURS
AVERAGE NUMBER OF C.C. OF GAS PRODUCED PER HOUR
TIME IN HOURS

FIG. 1. Gas production from 200 gms. rumen ingesta originating from a standard ration with silage and a standard ration without silage. (Based on readings taken at 1, 2, 3, 4, 5 and 20 hrs. after start of fermentation.)

tion due to the inclusion of silage in the ration. The cause of this slower rate of fermentation is not definitely known although acetic or lactic acid has the same effect when added to silage-free ingesta. Preliminary trials indicated that small amounts of lactic acid actually stimulated fermentation. But with acetic acid, fermentation was only about one-tenth of normal when as little as two per cent of acetic acid was mixed with the rumen contents.

TABLE 1

Total gas produced by 200-gram samples of ingesta when the cow was fed two typical farm rations

	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
Typical ration, with silage						
Average of 24 samples	43.7	89.0	126.8	159.1	188.3	361.4
Typical ration, without silage						
Average of 30 samples	87.2	162.2	219.6	262.7	297.9	609.2

Since *in vitro* trials always showed a steady drop in rate of fermentation, it seemed wise to determine how much of this drop was due to a decrease in available nutrients and how much was due to the accumulation of toxic

metabolic products. The effect of inanition is shown in table 2. When feed was withheld from the cow for 24 hours, three-fourths of the normal amount of ingesta in the rumen had disappeared. The remaining ingesta was considerably more alkaline than that of rumen contents where fasting did not occur. The cow from which the ingesta were obtained had access to water at all times. The water ingested and saliva secreted should have removed the major portion of the metabolic products produced by the organisms living in the first two stomachs. Just what percentage of the viable organisms was carried on into the true stomach is not known.

TABLE 2

Effect of withholding feed on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Gas production						H-ion concentration	
	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Check trials								
1	70.3	128.0	177.5	216.0	252.3	542.5	6.20	5.25
2	67.0	131.0	185.5	227.5	263.2	566.3	6.59	5.51
3	72.3	134.3	186.8	221.8	252.8	525.7	‡	‡
Ave.	69.9	131.1	183.3	221.8	256.1	544.8	.....	.....
Feed withheld for 24 hours								
1	†	†	20.0	25.0	30.0	173.2	7.86	7.25
2	†	†	14.0	22.5	28.3	114.5	8.02	6.92
3	†	18.2	38.3	60.5	70.7	344.5	‡	‡
Ave.	†	18.2	24.1	36.0	43.0	210.7	.....	.....

* Each figure is an average of six samples.
† Gas volumes so small that readings were highly inaccurate.
‡ No pH readings taken.

These results were compared with dilution of the rumen contents *in vitro* (table 3). Where the amount of ingesta used remained constant little effect was noted on total gas production by adding moderate amounts of distilled or tap water. Although it might be suspected that the additional water would tend to submerge the ingesta in the flasks, actually this did not occur. As soon as gas began to form, the ingesta would quickly rise to the top of the liquid or be "blown" into a less dense mass which extended well above the water line. No attempt was made to agitate the flasks of ingesta regularly although occasionally all flasks were shaken to prevent the material from overflowing the flasks. Preliminary trials indicated that covering the ingesta in the flasks with CO_2 or bubbling air through it only slightly modified fermentation. In all cases fermentation was somewhat increased in the presence of air.

TABLE 3

*Effect of dilution with distilled water on rate of fermentation of rumen ingesta as measured by total gas production**

Trial number	Water added per 200 grams of ingesta	Gas production					
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.
		cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
		Check samples					
1	.....	54.3	123.3	172.7	223.7	258.0	564.7
2	.....	36.3	80.0	126.0	159.0	190.3	504.0
3	.....	69.7	124.0	160.3	199.7	237.7	528.7
4	.....	70.7	145.7	197.0	238.7	268.7	598.0
5	.....	67.7	136.3	196.0	242.0	276.0	597.0
Ave.	.....	59.7	121.9	170.4	212.6	246.1	558.5
		Diluted samples					
1	50	50.3	112.3	160.7	208.7	244.3	530.3
2	50	29.5	69.5	114.5	147.5	178.0	499.0
3	50	65.3	117.3	155.0	195.3	230.7	532.3
4	100	42.7	94.3	141.0	176.3	203.0	514.7
5	100	55.0	118.0	173.0	218.0	252.0	594.0

* Each figure is an average of triplicate samples.

When the cow drinks large amounts of water the rumen contents are not only diluted but, in winter at least, the bacteria may be temporarily cooled below the optimum temperature for growth. Probably a more important factor would be changes in temperature of the ingesta due to prolonged

TABLE 4

Effect of temperature on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Gas production						H-ion concentration	
	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
	Samples held at 38.5° C. (check)							
1	111.0	191.0	248.3	294.3	333.7	619.0	5.89	5.37
2	108.7	177.0	229.7	272.7	310.7	595.3	5.94	5.44
3	70.0	127.3	174.3	209.3	235.7	483.3	5.76	5.45
Ave.	96.6	165.1	217.4	258.8	293.4	565.9	.....	.....
	Samples held at 42.5° C.							
1	133.0	215.0	276.0	321.0	357.0	612.7	5.89	5.35
2	140.3	222.3	291.7	344.0	385.7	668.7	5.94	5.45
3	84.0	148.0	196.0	231.0	258.3	472.0	5.76	5.47
Ave.	119.1	195.1	254.6	298.7	333.7	584.5	.....	.....

* Each figure is an average of triplicate samples.

TABLE 5

Effect of temperature on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Gas production						H-ion concentration	
	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples held at 38.5° C.								
1	81.3	139.0	179.3	217.7	249.0	506.7	5.90	5.30
2	85.0	154.3	208.3	250.0	285.7	580.0	5.83	5.30
3	76.7	141.3	189.7	226.3	255.3	527.3	5.89	5.48
Ave.	81.0	144.9	192.4	231.3	263.3	538.0	.....	.....
Samples held at 40.5° C.								
1	89.3	147.7	188.7	225.0	254.0	473.7	5.90	5.48
2	104.0	180.3	230.0	271.7	305.7	583.7	5.83	5.28
3	89.3	154.0	202.3	235.3	265.3	508.3	5.89	5.29
Ave.	94.2	160.7	207.0	244.0	275.0	521.9	.....	.....

* Each figure is an average of triplicate samples.

differences in external environmental temperature or to differences in heat production as the result of altered fermentation. By using two constant temperature baths it was possible to study these changes on aliquot samples of ingesta (tables 4, 5 and 6). Changes of two to four degrees in temperature only slightly altered the rate of gas production. Greater changes than

TABLE 6

Effect of temperature on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Gas production						H-ion concentration	
	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples held at 38.5° C.								
1	60.3	106.7	146.3	176.7	201.7	449.7	5.87	5.51
2	72.3	127.7	170.0	205.0	236.7	466.7	5.98	5.58
3	64.7	121.0	169.0	209.3	243.3	499.0	5.92	5.57
Ave.	65.8	118.5	161.8	197.0	227.2	471.8	.....	.....
Samples held at 36.5° C.								
1	45.7	89.0	126.0	152.7	176.7	422.3	5.87	5.50
2	60.7	113.0	149.3	181.0	209.3	438.3	5.98	5.59
3	52.3	100.3	139.3	173.3	205.0	445.3	5.92	5.61
Ave.	52.9	100.8	138.2	169.0	197.0	435.3	.....	.....

* Each figure is an average of triplicate samples.

this, such as are caused by the drinking of large amounts of cold water, are so temporary that they have not been considered in this study.

As already mentioned, the hydrogen-ion concentration of the rumen contents varies within comparatively wide limits. With the exception of the fasting condition, the pH of the rumen contents studied varied between 5.75 and 6.99 (tables 2, 4, 5, 6, 7, 8, 9 and 11). At the end of 20 hours' fermentation *in vitro* the pH had dropped to 5.5–5.25. Under certain experimental conditions (table 11) the pH rose to 8.42 after 20 hours of fermentation *in vitro*.

Most of the readings taken while the cow was receiving a ration of alfalfa hay and grain were around pH 6.3 whereas with those taken while the cow was receiving bluegrass pasture and grain, only one reading was higher than pH 6.0. These observations would indicate a definitely more acid condition of the rumen ingesta when the cow was on pasture. Furthermore, this decline in pH was accompanied by a 16 per cent reduction in gas production during 20 hours' fermentation of the ingesta *in vitro*.

TABLE 7

Effect of 10 per cent sodium hydroxide on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	10% sodium hydroxide per 200 grams of ingesta	Gas production						H-ion concentration	
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples without sodium hydroxide									
1	.....	89.0	157.5	208.0	244.0	280.5	526.5	5.80	5.38
2	.....	76.0	141.0	186.5	225.0	256.0	527.0	6.03	5.60
3	.....	70.0	132.5	176.0	212.0	245.5	516.0	5.86	5.47
Ave.	.....	78.3	143.7	190.2	227.0	260.7	523.2	.....	.....
Samples with sodium hydroxide added									
1	1	89.5	161.0	219.5	258.0	299.0	579.5	5.80‡	5.50
1†	3	85.5	150.0	200.0	237.5	277.0	642.5	5.80	5.58
2	3	76.0	139.5	188.0	228.5	266.0	647.5	6.03	5.76
2†	10	52.0	95.5	123.5	148.0	171.5	477.5	6.03	6.85
3	20	22.0	31.5	45.5	50.5	55.0	129.5	5.86	6.80

* Each figure is an average for duplicate samples.

† Two experimental series containing different amounts of sodium hydroxide were run concurrently with each check series.

‡ Before addition of sodium hydroxide.

A number of attempts were made to influence the hydrogen-ion concentration *in vitro*. As already mentioned acetic and lactic acid materially decreased gas production. No pH determinations were made in these trials. The adding of agricultural limestone to the samples of ingesta had very little

effect on the pH although it did accelerate fermentation (table 8). Small amounts of sodium hydroxide, if anything, slightly increased fermentation (table 7). On the other hand, ten and twenty cubic centimeters of 10 per cent sodium hydroxide raised the pH of the ingesta and definitely inhibited fermentation. Adding as much as 20 cubic centimeters of tenth normal hydrochloric acid to the flasks of ingesta had almost no effect on the rate of gas production (table 9). The pH of the experimental and the check samples were quite similar after twenty hours' fermentation.

TABLE 8

Effect of agricultural limestone on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Limestone per 200 grams of ingesta	Gas production						H-ion concentration	
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	gms.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples without limestone									
1	.....	82.0	166.7	224.0	269.3	310.7	694.0	.....	.....
2	.....	85.7	162.7	213.7	259.0	297.3	538.7	.....	.....
3	.....	83.7	163.7	230.7	273.0	313.3	722.3	6.48	5.28
4	.....	67.7	134.7	192.7	239.3	276.0	623.0	5.89†	5.37†
5	.....	65.0	136.7	192.0	230.0	264.0	597.3	5.89†	5.48†
Ave.	.....	76.8	152.9	210.6	254.1	292.3	635.1	.....	.....
Samples with limestone added									
1	0.5	80.0	167.3	225.3	278.0	319.7	744.7	.....	.....
2	1.0	96.0	180.7	239.3	289.7	332.7	745.0	.....	.....
3	1.0	107.7	199.3	274.3	323.3	374.7	852.3	6.48‡	5.45
4	5.0	80.0	159.3	230.0	290.7	337.7	866.0	5.89†	5.46†
5	10.0	76.7	163.3	231.0	277.7	327.0	778.0	5.89†	5.46†

* Each figure is an average for triplicate samples.

† These readings were not obtained on the same samples that were used for the determination of gas production. However, the treatment was the same.

‡ Before the addition of agricultural limestone.

In that most simple forms of life depend upon rather fixed osmotic pressures of the milieu in which they live, it seemed reasonable to suspect that changes in the sodium chloride concentration might be important in this study. Besides, a frequently heard suggestion on how to prevent bloat is to add salt to the drinking water. However, results obtained in our experiments would tend to discourage this practice (table 10). Amounts of salt which the cow might tolerate in the drinking water, as determined by tasting, had no inhibitory effect on gas production by the rumen flora. In fact, the tendency was toward an acceleration in gas production. Other home remedies, such as equal parts of soda, salt and limestone, had no inhibitory effect on these organisms as measured by gas production. Limestone noticeably stimulated fermentation.

TABLE 9

Effect of N/10 hydrochloric acid on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	N/10 HCl per 200 grams of ingesta	Gas production						H-ion concentration	
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
		cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples without hydrochloric acid									
1	.....	168.0	265.0	327.5	383.0	433.5	736.0	6.64	5.49
2	.....	104.0	167.5	218.0	264.0	303.5	637.0	5.90	5.39
3	.....	102.0	175.7	239.9	290.7	331.3	632.3	6.44	5.24
4	.....	104.7	205.3	266.0	312.0	347.7	700.0	6.64	5.40
5	.....	121.0	205.7	269.3	316.7	358.0	725.7	6.34	5.32
Ave.	.....	119.9	203.8	264.1	313.3	354.8	686.2	.....	.....
Samples with hydrochloric acid added									
1	0.3	174.7	275.0	340.0	400.0	450.0	779.0	6.64†	5.60
2	1.0	106.3	172.3	224.3	269.7	310.7	657.3	5.90	5.38
3	3.0	95.3	169.0	229.3	276.0	314.7	618.7	6.44	5.21
4	10.0	110.0	213.7	275.7	321.0	362.0	700.0	6.64	5.29
5	20.0	110.7	192.7	250.3	296.3	337.3	677.0	6.34	5.17

* Each figure in the check samples of trials 1 and 2 is the average of duplicate samples. All others are averages for triplicate samples.

† Before addition of HCl.

TABLE 10

*Effect of sodium chloride on rate of fermentation of rumen ingesta as measured by total gas production**

Trial number	Sodium chloride per 200 grams of ingesta	Gas production					
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.
	gms.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
Samples without sodium chloride							
1	.....	109.3	177.0	248.0	286.7	321.7	662.3
2	.....	83.0	162.3	210.7	251.3	286.0	611.3
3	.....	105.7	188.0	248.3	293.3	333.3	603.3
4	.....	87.0	160.7	209.7	246.7	282.3	610.7
5	.....	88.0	158.0	211.7	256.7	287.7	623.3
Ave.	.....	94.6	169.2	225.7	266.9	302.2	622.2
Samples with sodium chloride added							
1	0.5	123.3	206.0	268.3	307.7	349.3	692.7
2	1.0	82.3	159.7	204.7	248.7	279.3	595.7
3	1.0	110.0	194.0	257.0	302.3	341.7	623.7
4	5.0	77.0	141.3	186.3	218.0	250.7	483.3
5	10.0	78.3	138.0	186.0	226.7	251.7	497.7

* Each figure is an average of triplicate samples.

Quite a number of preliminary trials were run with other materials in the hope of throwing more light on the physiology of excessive gas production in the rumen. Molasses and a few pure sugars were tried. These supposedly good bacterial foods tended to inhibit gas production temporarily. Longer trends were not studied *in vitro* although it was noticed that the rumen contents became more frothy when molasses was fed regularly to the cow. Vitamins such as thiamin chloride, ascorbic acid and calcium pantothenate when used singly in preliminary trials showed no marked effect on gas production. Glycerol and urea only slightly modified fermentation when small amounts were used. However, ten grams of urea per flask completely inhibited gas production.

One of the more interesting compounds tried was sodium formate (table 11). This material, in all amounts used, very definitely stimulated fermen-

TABLE 11

Effect of sodium formate on rate of fermentation of rumen ingesta as measured by total gas production and hydrogen-ion concentration*

Trial number	Sodium formate per 200 grams of ingesta	Gas production						H-ion concentration	
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	20 hrs.	0 hrs.	20 hrs.
	gms.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*pH*	*pH*
Samples without sodium formate									
1	.....	122.3	199.0	251.7	292.3	330.0	742.0	.....	.....
2	.....	98.3	184.3	243.7	291.7	327.7	663.7	6.06†	5.43†
3	.....	100.7	191.7	244.3	296.0	332.3	683.3	5.75†	5.29†
4	.....	92.0	169.7	224.3	276.0	308.0	558.7	5.78†	5.48†
5	.....	129.7	205.3	260.3	305.0	346.0	705.3	6.65	5.48
Ave.	.....	108.6	190.0	244.9	292.2	328.8	670.6	.....	.....
Samples with sodium formate added									
1	0.5	151.7	246.0	314.7	380.3	430.3	965.3	.....	.....
2	0.5	118.0	228.0	301.7	368.3	421.0	876.7	6.06†	7.00†
3	1.0	130.3	251.3	326.0	399.3	459.7	1042.3	5.75†	7.47†
4	1.0	120.0	217.3	290.7	357.3	415.3	840.3	5.78†	7.17†
5	2.0	166.7	274.0	361.7	428.7	485.0	1158.0	6.65	8.42

* Each figure is an average of triplicate samples.

† These readings were not obtained on the same samples that were used for the determination of gas production. However, the treatment was the same.

tation and raised the pH of the fermented material. Calcium formate, sodium lactate, calcium lactate and calcium gluconate gave similar but less marked increases. More detailed study will be necessary to clarify the results. Although it is probably as necessary to provide a "balanced ration" for bacteria as for dairy cows, very few of these compounds were tried in combination, principally due to the lack of time. Milk was tried and in limited amounts tended to increase fermentation about 30 per cent. The authors were not especially interested in drugs which would inhibit fermen-

tation as it was felt that fermentation is a normal physiological process which must be encouraged if the cow is to derive the maximum good from her feed, especially high fiber feeds.

One of the chief reasons for starting this investigation was to learn why cows bloat more readily on legume pasture than on any other feed and why some cows bloat on legume pasture under one set of conditions and not under another. Probably the most surprising thing we found was that similar amounts of bluegrass and green alfalfa when partially submerged in aliquot samples of rumen fluid produced almost the same amount of gas. In fact the rates of gas production tended to follow the dry matter content of the materials used even when the grass was dried before immersing in the rumen fluid. Unfortunately, varying amounts of material were used in this set of trials and the time at which readings were made did not coincide in each trial so the data cannot be readily summarized in table form. Freshly frosted alfalfa and alfalfa covered with dew when cut was also tried but no acceleration in rate of fermentation was noted. Even freezing green alfalfa and then grinding it while frozen did not alter the end results beyond the limits of experimental error. Besides the *in vitro* trials, an effort was made to change the cow to feed which had been frosted but this did not prove practical. However, it was found that the dry matter content of the rumen ingesta was not materially different when the cow was on dry or green feed.

No determinations were made of the gas as produced. Analyses of the total gas produced in 20 hours showed a carbon dioxide content of around 50 per cent.

An attempt was made to induce bloat by turning cows into a field of young alfalfa. These cows refused to eat alfalfa for any extended time with the result that conditions favorable for bloat could not be obtained. It was noted, however, that at first these cows were eating the fresh alfalfa at the rate of one pound per minute while the best rate at which they ate good bluegrass pasture was one-third of a pound per minute. It might be added in explanation of this difference in rate of ingestion that fresh alfalfa is more or less pinched off by the cow in grazing while bluegrass must be gripped firmly and the grass cut off against the sharp edges of the lower teeth. The data on rate of grazing were obtained by weighing the cow immediately before and after grazing. All excreta voided was collected and corrected for.

DISCUSSION OF RESULTS

From the results obtained it is evident that temporary changes, though of a substantial nature, can be made in the environment of bacteria in the rumen without seriously affecting the rate of gas production. Long-time trends were not of interest in this experiment because of unpredictable changes in bacterial flora which might also occur.

Nothing in these results would indicate that the rate of fermentation in

the rumen can be increased precipitously by the addition of many of the more common sugars, minerals, or vitamins associated with proper nutrition. Even under normal conditions gas is generated too rapidly to be absorbed without a frequent eructation of gas. In fact, our results would indicate that green alfalfa does not stimulate gas production any more than green growing bluegrass. This has led us to seek a physical explanation for bloat. Because our cows ate alfalfa three times as fast as bluegrass, added weight is given to this explanation.

The fact that injury from fermentation in the paunch never occurs with cows on legume pasture unless they bloat, would tend to indicate that the gases formed are not especially toxic. Most cows will be seen to eruct gas two or more times per minute while grazing. True, under increased pressure the rate of absorption of the gases produced is much greater and may be a contributing factor to death from bloat. However, the failure of the gas to escape normally appears to be the predisposing factor.

Roughage as ingested is dropped from the cardia into the recticulum and anterior compartment of the rumen. By running bluegrass and alfalfa through a meat chopper to simulate chewing, it was found that chopped alfalfa forms a much more compact mass than chopped bluegrass. At the rate of grazing actually observed with cows which had been without food for 12–18 hours it is quite possible that such animals might ingest 50–100 or more pounds of this succulent feed before resting. This amount of material if remaining in a relatively compact mass would tend to force the stomach down against the abdominal floor. And since the only entrance or exit to the stomach is at the esophageal groove anything which would tend to depress the esophageal groove below the level of the fluid in the fore stomachs would tend to cause trapping of the gas within the rumen and bloating. This condition would be aggravated by the cow lying down after grazing to rest and chew her cud. As fermentation began to increase the freshly eaten mass would be buoyed up by the generated gas and might help to block the escape of the gas. Increased pressure would only seal the exit more firmly. The drinking of water might tend to help wash part of this freshly eaten mass back into the rumen where it would normally be carried by the peristaltic contractions of the reticulum. On the other hand, if the mass was not dislodged the water would only make it more difficult for the gas to escape.

By palpation of the fore stomachs through a rumen fistula one finds that the reticulum contracts periodically with considerable force. This peristaltic wave throws the fluid in the reticulum over the more solid material in the rumen. A slow peristaltic wave then passes over the rumen and tends to squeeze out much of this fluid, taking with it some of the soluble material freed by soaking, maceration and bacterial action. The semi-liquid material flows forward into the reticulum. When a cow quickly ingests large

amounts of feed which compacts readily there appears to be danger of upsetting this normal physiological process. Certainly the danger of bloating is greatest immediately after grazing.

This theory would account for the greater prevalence of bloating when cattle graze alfalfa covered with dew or frost by assuming that moistened feeds can be ingested more rapidly than unmoistened feeds. Less saliva would also be added to the fermenting material. As has already been mentioned, it was impossible to get any of the cows, including the one with the rumen fistula, to eat sufficient alfalfa during the experiment to simulate the conditions described.

SUMMARY

Ingesta obtained from a cow by means of a rumen fistula were fermented *in vitro* and the gas collected over twenty-hour periods. Ingesta obtained after the cow had eaten silage produced less gas per gram of dry matter than ingesta obtained when the cow received only hay and a mixed grain ration. Bluegrass pasture and grain produced an ingesta definitely more acid than did alfalfa hay and grain. The ingesta normally became more acid as fermentation progressed. This increase in acidity was accompanied by a decline in rate of gas formation.

When feed was withheld from the cow for 24 hours, her rumen was not more than one-fourth full and most of the material present was in a semi-liquid state. Ingesta obtained at this time was alkaline and the rate of gas production was very slow.

Aliquot samples of the rumen contents were treated in different ways and the rate of fermentation compared. Changes in dilution, temperature and hydrogen-ion concentration, in the ranges normally occurring in the stomach, had little effect on the rate of fermentation. Amounts of salt which the cow would tolerate in her drinking water also had little effect in *in vitro* studies. Common minerals, such as limestone, accelerated fermentation probably through neutralization of the acids formed. Of a number of other materials tried, acetic and lactic acids tended to depress fermentation most severely while sodium formate had the greatest accelerating influence.

Finding no basis for bloat as a result of altering the environment of the bacteria in rumen ingesta, the authors propose a theory based upon the physical effect of the feed. This theory was not verified experimentally due to a lack of cooperation by the cows under observation.

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PREVENTION OF DEVELOPMENT OF HYDROLYTIC RANCIDITY IN MILK

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Hydrolytic rancidity in milk manifests itself by imparting the somewhat bitter taste and the sharp, unpleasant aroma characteristic of fat acids of low molecular weight, especially butyric acid. A partial hydrolysis of milk fat, which is responsible for rancid flavor, can be brought about by two distinct sets of conditions.

1. Hydrolysis will result from certain specific treatments of raw milk such as (a) homogenization (1), (b) violent shaking of warm milk (5), (c) warming of the precooled milk to about 30° C. and cooling again below 10° C. (4). These treatments of milk result in the activation of lipase, an enzyme seemingly present in all raw supplies of milk (3). Whether one or more lipolytic enzymes are involved in the hydrolysis of milk fat by activation treatments is a question (2); but normally, in any case, the rancid flavor does not appear unless the milk is subjected to one of the treatments mentioned above. As was pointed out by Tarassuk and Richardson (10), lipase-activation treatments of milk have one property in common: they lead to disruption, partial replacement, or distortion of the natural adsorption layer on the fat globules; and therein lies the clue to the mechanism of activation.

2. During winter feeding when cows have no access to green feed, the milk from some cows (usually those that are late in lactation) contains a naturally active milk lipase. This milk exhibits a spontaneous lipolysis of fat since no involved treatment is necessary in order to make it become rancid upon aging. The only condition necessary for the activation of this lipase is cooling (9). Once the milk has been cooled, lipase activity is not materially affected whether it is aged in the cold or rewarmed immediately to 20°, 30° or 37° C. and aged at those temperatures. The critical cooling temperature is between 20° C. and 15° C., and the rate of lipase action is increased with progressive cooling to lower temperatures.

The extent of occurrence of spontaneous rancidity in milk is reportedly from 3.2 (6) to 35 per cent (7) of milk sampled at the delivery plant as being rancid. The present available methods for preventing the rancidity caused by naturally active milk lipase are (a) pasteurization shortly after milking, and (b) detection of cows whose milk will become rancid on cooling and aging, and the elimination of their milk from the marketable supply. The first method of prevention is usually impracticable or impossible; and the

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second is uneconomical, especially now that a national effort is being put forth to increase milk production.

In the present study a new method of preventing spontaneous lipolysis is presented. This method obviates the economic loss and is simple enough to be practicable.

EXPERIMENTAL RESULTS

The lipolysis of milk fat caused by a naturally active lipase in milk takes place upon cooling and aging. When the concentration of lipase is sufficiently high, the rancid flavor becomes perceptible on aging for only 3 hours. In such milk the rate of lipolysis, according to Tarassuk (8), is highest in the first 10 hours. The further rate of hydrolysis by lipase is progressively reduced by accumulation of the products of hydrolysis and

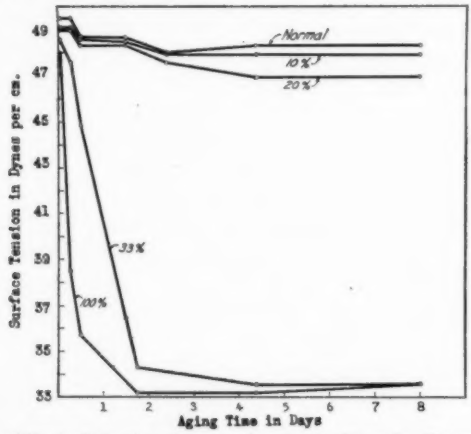

FIG. 1. Rate of lipolysis in the mixtures of normal milk and milk containing naturally active lipase in very high concentration.

by lowering of the pH. As is well known, if such milk after cooling and aging for 24–36 hours is mixed with a normal milk, the admixture of even 3–5 per cent of it will impart a rancid flavor to the entire mixture.

In this work the progress of lipolysis was studied in the various mixtures of normal milk and milk containing naturally active lipase when the two are mixed within less than one hour after milking—that is, before the development of rancidity in potentially rancid milk.

The rate of lipase action was determined by measuring the surface tension of milk (8) with a Du-Noüy tensiometer at 20° C. The mixing was done within an hour after milking, before cooling or immediately after cooling. All samples were brought to 3–5° in ice water and aged at 5° C. The surface tension was measured at intervals during aging. The surface-tension data were supplemented also by organoleptic test of milk by two experienced judges.

Figures 1, 2, and 3 illustrate the data on the rate of hydrolysis of milk fat by a naturally active lipase when the various milks containing this lipase on different occasions and from different cows were mixed with a normal milk[1] within an hour after milking. The percentage as shown on the curves refers to the per cent of potentially rancid milk that was added.

Figure 1 illustrates the rate of hydrolysis of milk fat in milk containing a very high concentration of a naturally active lipase. As can be seen from the curve (100 per cent) in figure 1, the hydrolysis is nearly completed within twelve hours. This particular milk tested rancid within two hours after cooling; yet when 20 per cent of this milk was mixed with a normal milk within one hour after milking, the mixture failed to develop the rancidity perceptible by organoleptic test on aging for nine days. Judging

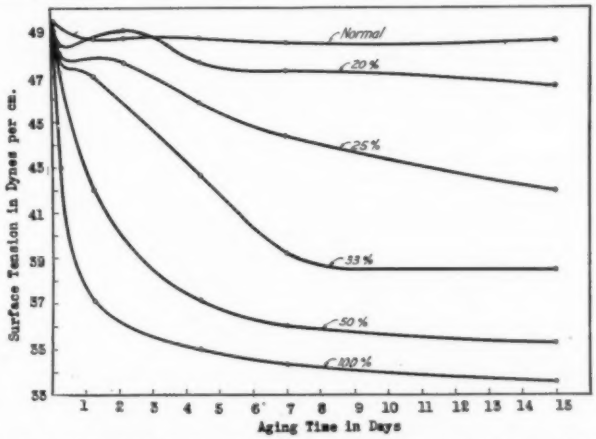

FIG. 2. Rate of lipolysis in the mixtures of normal milk and milk containing naturally active lipase in high concentration.

from the data in this figure, there is a critical concentration of lipase below which the rate of hydrolysis falls to such extent that the presence of lipase in concentrations below the critical one has no practical importance. The hypothesis of critical concentration of lipase is supported also by figures 2 and 3. In figure 2 the lipolytic activity of "lipase milk" is also unusually high, although less than that shown in figure 1. In this case an admixture of 75 per cent of normal milk delayed the development of perceptible rancid flavor for three days—an average life of market milk. The mixture of 20 per cent of "lipase milk" and 80 per cent of normal milk failed to develop a rancid flavor on aging for as long as fifteen days.

[1] The term "normal milk" as used here means milk that will not show any appreciable hydrolytic rancidity on cooling and aging for three days, as can be determined by organoleptic test or by surface-tension measurements.

Figure 3 represents the average lipolytic activity of milk that goes rancid spontaneously. As can be seen from the rate of hydrolysis, such milk shows a pronounced rancidity on cooling and aging for 24 hours or longer. As is evident from figure 3, the development of rancid flavor in such milk can be

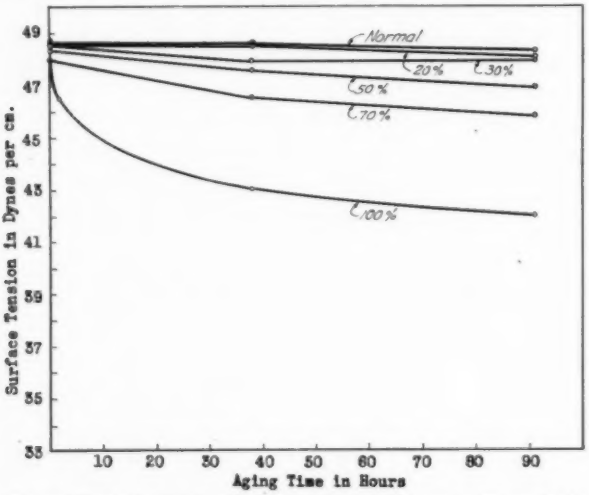

FIG. 3. Rate of lipolysis in the mixtures of normal milk and milk containing naturally active lipase in average concentration.

prevented for a period longer than the average life of milk by mixing it with a normal milk in a proportion even as great as 1 : 1. The average organoleptic score given by two judges to the mixtures of the milks represented in figure 3 appears in table 1. The samples were keyed and scored as unknowns placed in random order.

TABLE 1

*Organoleptic score of mixtures of normal and potentially rancid milk after various aging periods**

Sample	Time of Aging		Criticism
"Lipase milk" in milk	38 hours	91 hours	
per cent			
100	0	0	Very rancid
70	18	16	Slightly rancid and rancid
50	23	23	No criticism
30	23	23	No criticism
20	23	23	No criticism
0 (normal)	23	23	No criticism

* The milk-score card of the American Dairy Science Association allows 25 points for a perfect flavor score. By custom, milks with no flavor defects are given a score of 23 to 24.

The data demonstrate clearly that the rate of lipolysis of milk fat due to a naturally active lipase does not follow the rate of dilution of the enzyme when a dilution is made by mixing with normal milk. In general the lipolysis curves at higher concentration of the enzyme have the characteristics of an exponential curve. When the original "lipase milk" is diluted 1:3 or higher with a normal milk, the rate of lipolysis after the first few hours of aging approaches a straight line, which is rather characteristic of a normal milk.

Since very seldom will more than one out of five cows in a herd give milk that goes rancid spontaneously, the mixing of the herd's milk will prevent the development of rancid flavor. This method of preventing hydrolytic rancidity in milk is not equally applicable to a separated cream. The experimental work is being done to study this phase of the problem.

This method of mixing also cannot be applied for the prevention of the development of rancidity resulting from activation of lipase of normal milk by temperature changes as stated previously. In the latter case the rate of lipolysis of milk fat seemingly follows the rate of dilutions and the details of this study will be reported in a subsequent paper.

SUMMARY

The development of hydrolytic rancidity in raw milk by a naturally active lipase present in high concentration can be successfully prevented by mixing with normal milk within an hour after milking. The amounts to be mixed depend upon the concentration of the lipase. The mixing of "lipase milk" with normal milk in a proportion of 1:4 or higher will always prevent rancidity. To insure the effectiveness of this method the mixing must be made within an hour after milking, before cooling or immediately after cooling. If a milk containing a naturally active lipase is allowed after cooling to age separately and thus to become rancid, then the addition of very small amount to a normal supply will impart the rancid flavor to the whole mixture.

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SHARK LIVER OIL AND THE VITAMIN A POTENCY OF MILK*

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INTRODUCTION

The vitamin A activity of winter milk usually is lower than that of summer milk due to the reduced carotene intake of cows maintained on winter rations. It is well known that the vitamin A activity of milk is dependent on the level of carotene and vitamin A in the ration. The data presented herein are the result of an attempt to increase the vitamin A potency of winter milk.

REVIEW OF LITERATURE

Reports in the literature have shown that feeding carotene, whether as green pasture or hay in amounts as high as 6,000,000 International Units (I.U.) of vitamin A per cow per day, has never resulted in butter containing more than 56 I.U. of vitamin A per gram, nor milk containing over 2500 units per quart (2, 18, 20, 21, 22).

Archibald and Parsons (1) fed a fortified cod-liver oil with the dairy ration and reported a significant increase in the vitamin A level of the milk from these animals as compared with those receiving unsupplemented rations. They reported 3596 units of vitamin A per quart of milk when cod-liver oil (3000 U.S.P. units of vitamin A per gram) was fed at 0.25 per cent level in the grain. The vitamin A assays of the milk in two consecutive years did not agree because of a change in the quality of the roughage used in the basal ration. These investigators noticed a favorable effect on milk production and found no significant effect on the average butterfat content of the milk.

Deuel *et al.* (3, 4) administered 700,000 and 1,400,000 I.U. of vitamin A in the form of shark-liver oil to Guernsey cows and observed a corresponding increase in the vitamin A potency of the milk, proportional to the amount of vitamin fed. The basal diet included large amounts of fresh-cut alfalfa and baled alfalfa hay. These workers reported an average of 113 I.U. of vitamin A per gram of butterfat after daily administration of 1,400,000 I.U. of vitamin A as shark-liver oil, and as high as 172 I.U. of vitamin A per gram of butterfat with one animal. These analyses were

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The data in this paper were taken in part from a Doctor's thesis submitted by H. E. Skipper to the Graduate School of the University of Florida, June 1941.

colorimetric, using a Bills-Wallenmeyer electronic photometer, although bioassays on a few samples showed a slightly lower potency. Under the conditions of their experiment apparently no threshold level was reached. They reported also a 10 per cent increase in the milk production of the cows receiving shark-liver oil and a slightly greater increase of butterfat. In a second experiment these workers reported a potency of 55 I.U. of vitamin A per gram of butter from cows receiving shark-liver oil.

It has been reported that high concentrations of cod-liver oil decreased the percentage of butterfat (5, 7, 11, 12, 13); that cod-liver oil concentrate had no effect (1); that shark-liver oil either had no effect (11), increased (4), or decreased the percentage of butterfat (17). Guthrie (6) reported that a high vitamin A ration would increase the vitamin C content of the milk. The effect of feeding shark-liver oil in the ration on the vitamin A potency, butterfat percentage, and ascorbic acid content of milk will be reported herein.

EXPERIMENTAL METHODS

Ten Jersey cows selected from the Florida Agricultural Experiment Station dairy herd were used. They were selected as nearly uniform as possible as regards milk and butterfat production, and stage of lactation. These cows were placed in four groups: Groups I, II, and III, consisting of two animals each, and a control group containing four animals. The experiment was divided into three feeding periods: a preperiod before supplementation with shark-liver oil, a dry lot or winter period with oil supplementation, and a pasture or spring period with oil supplementation.

The basal ration was the regular dairy herd ration which consists of a well-balanced concentrate mixture and silage made from corn, well matured and well eared. During the winter period, Alyce clover (*Alysicarpus vaginalis* (L.) DC.) hay was added to the basal ration at the level of approximately eight pounds per head daily. The control group received only the basal ration, whereas Groups I, II and III received 2.5, 5.0 and 10 pounds of shark-liver oil (9,000 I.U. of vitamin A per gram), respectively, per ton of the mixed concentrates. The shark-liver oil was incorporated in the wheat bran which was then mixed with the other constituents of the concentrate mixture. Fresh batches of feed were prepared at 30-day intervals. The cows received approximately 10 pounds of the concentrate mixture and 20 pounds of corn silage per head daily.

The shark-liver oil and Alyce clover hay were assayed biologically for vitamin A by the U.S.P. XI technique (15). The carotene contents of the basal ration, corn silage and Alyce clover hay were determined by the method of Peterson, Hughes and Freeman (14).

Composite milk samples for a 24-hour period were collected from each cow at the end of each experimental period. The ascorbic acid content of each milk sample was determined immediately after collection by the method of

Sharpe (19). The butterfat content of each milk sample was determined by the Babcock method. The milk from cows of the same group was then mixed, heated to 143° F. for ten minutes, homogenized at 43,000 pounds pressure per square inch, placed in half-pint carton containers and stored at 0° F. awaiting bioassay.

In previous biological assays of milk for vitamin A, it was found that 0.5 cc. per rat daily resulted in a large percentage of deaths before the end of the assay period. Therefore, 1 cc. of milk per rat daily was the level fed.

A growth-response curve for the U.S.P. reference cod-liver oil was established for the rat strain used in this laboratory. The growth responses on the milk samples were compared with this reference growth-response curve, as were the growth responses of the rats on shark-liver oil and Alyce clover hay.

RESULTS

The shark-liver oil assayed at least 9,000 I.U. of vitamin A per gram, Alyce clover hay approximately 170 I.U., and the corn silage 1.4 I.U. The basal concentrate mixture showed no appreciable vitamin A activity.

Table 1 gives the approximate daily vitamin A content of the rations for the different groups of cows receiving shark-liver oil, and the vitamin A potency per quart of milk from these groups of animals for the different periods.

TABLE 1

The vitamin A potency per quart of milk from cows receiving shark-liver oil

Group	Supplement of oil per ton of mixed concentrates	I.U.* of vitamin A per day in the ration	Vitamin A potency per quart of milk		
			Pre-period	Dry lot period	Pasture period
	lbs.		*I.U.*	*I.U.*	*I.U.*
Basal†	0.0	744,000	1740	1570	1730
I	2.5	795,000	1880	1845	2035
II	5.0	846,000	1845	1890	1880
III	10.0	948,000	1770	1910	1875
Cow #601	6 oz. per day	2,144,000	.....	.....	1750

* I.U. = International unit of vitamin A.

† Basal ration

	I.U. of Vitamin A per cow per day
Grain mixture	0
Corn silage	127,000
Alyce clover hay	617,000
	744,000

The feeding of high levels of shark-liver oil slightly lowered the percentage butterfat of milk as shown in table 2.

The ascorbic acid content of the milk samples from each cow ranged from 17.2 to 20.4 mg. per liter during the control period; 15.0 to 19.8 mg. per liter during the dry lot period, and 17.7 to 25.3 mg. per liter during the period

TABLE 2

The relation of high intakes of shark-liver oil to the percentage butterfat of milk from Jersey cows

Cow No.	Level of oil fed daily	Percentage of butterfat				
		Before feeding oil	During and after oil feeding			
			Weeks			
			1	2	3	4
	oz.					
601	4	5.1	5.0	5.2	4.7*	5.4
637	6	4.0	4.75	3.8*	4.7	.....
539	6	3.7	2.2	3.1*	3.5	.....
564	6	4.5	3.7	4.3*	4.7	.....
602	6	4.8	4.75	4.7*	5.9	.....
435	6	5.05	4.2	4.1*	4.65	.....

* Feeding of shark-liver oil ceased after taking milk sample.

on pasture. Of the 30 samples a low value of 15.0 mg. of ascorbic acid was found in Lots I and III during the dry lot period, and the high value of 25.3 was found in Lot II in the spring period.

DISCUSSION OF RESULTS

In the preperiod and during the spring period the animals had access to succulent green pasture so that it was impossible to calculate the amount of vitamin A received in the form of carotene.

The most dependable vitamin A potencies of the rations are thus found for the dry lot or winter period, as indicated in table 1. These values ranged from 744,000 I.U. for the animals receiving no supplement of oil, to 948,000 I.U. with oil supplementation. The vitamin A potency of the milk ranged from 1570 to 1910 I.U. per quart. The addition of 0.125 per cent of shark-liver oil in the concentrates of the basal ration (Group I) raised the vitamin A intake from 744,000 to 795,000 I.U. per cow daily. This level of vitamin A in the ration was sufficient to produce milk of maximum vitamin A potency. Increasing the vitamin A potency of the ration above this level by further additions of shark-liver oil (0.25 and 0.50 per cent) did not further increase the vitamin A potency of the milk. Even when these animals were allowed to go on pasture in the spring period, receiving still more vitamin A in the form of carotene, no further increase in the vitamin A potency of the milk was observed. One cow (# 601) received six ounces of shark-liver oil in addition to the basal ration so that the total vitamin A in the ration amounted to 2,144,000 I.U. Even this very high level did not affect the vitamin A potency of the milk beyond that resulting from a ration containing 795,000 I.U. per day. Evidently, a threshold level for vitamin A secretion exists above which more vitamin A in the feed does not increase the vitamin A potency of the milk. The value, 795,000 I.U. of vitamin A

per cow per day, closely approaches the value of 550,000 Sherman-Munsell Units, or 770,000 I.U. (1.4 conversion factor) as reported by Wilbur, Hilton and Hauge (21) as necessary in the form of carotene to keep the vitamin A potency of butterfat at a maximum. Deuel *et al.* (3, 4) on the other hand, report no such threshold level in their experiment using Guernsey cows. They found a corresponding increase in the vitamin A potency of the butterfat as the amount of shark-liver oil in the ration increased, reporting as high as 172 I.U. of vitamin A per gram of butterfat (8600 I.U. of vitamin A per quart of milk, on the basis of five per cent butterfat).

It can be noted from table 1 that a significant decrease occurred in the vitamin A potency of the milk from cows of the basal group when pasture was eliminated from the ration during the dry lot period. An increase in the vitamin A potency of the milk for this group during the following pasture period shows the effect of good pasture on the vitamin A activity of milk.

Per cent of butterfat: The administration of four to six ounces of shark-liver oil daily to Jersey cows tended to decrease the percentage of butterfat slightly without affecting the quantity of milk produced. An increase of percentage of butterfat was observed with each animal on cessation of oil administration, as shown in table 2. McCay and Maynard (11) reported that the depressing effect on butterfat secretion caused by feeding cod-liver oil did not occur when shark-liver oil was used, while Deuel *et al.* (4) reported an increase of about 10 per cent in butterfat and milk production with the administration of shark-liver oil. Rupel, Boyer and Phillips (17) have recently reported that large amounts of shark-liver oil decreased the percentage of butterfat at the beginning of the oil feeding period. These data do not confirm the work of Deuel *et al.* (3, 4).

Ascorbic acid: Ascorbic acid is known to be synthesized within the body of the cow. Several investigators (8, 9, 10, 16) have observed that no relationship exists between ascorbic acid in feed and in milk, while Guthrie (6) in 1939 reported that the addition of vitamin A in the form of cod-liver oil increased the ascorbic acid content of milk. There were no indications that the vitamin A activity of the ration influenced the ascorbic acid content of the milk under the conditions of the experiment reported herein.

SUMMARY AND CONCLUSIONS

The vitamin A potency of milk, obtained from cows receiving 744,000 to 2,144,000 International Units of vitamin A per day in rations by the supplementation with shark-liver oil, ranged from 1570 to 2035 I.U. per quart.

The feeding of approximately 795,000 I.U. of vitamin A (0.125 per cent shark-liver oil in the concentrates) per cow daily resulted in milk of maximum vitamin A potency. It is suggested that a threshold level exists for the secretion of vitamin A in milk, since feeding higher levels of vitamin A did not result in further increases of this vitamin in the milk.

Administration of high levels (4 to 6 ounces) of shark-liver oil per cow daily tended to depress slightly the percentage of butterfat in the milk without affecting milk production.

There was no indication that high vitamin A potency of the ration influenced the ascorbic acid content of the milk.

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SEASONAL VARIATION IN SEMEN QUALITY OF THE DAIRY BULL[1]

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It has long been recognized that in many vertebrates spermatogenesis is not continuous but tends to occur at one rather definite period of the year. Cyclic spermatogenic activity is characteristic of the majority of mammals with the exception of such domesticated and semidomesticated species as the guinea pig, rabbit, rat, dog, boar, ram, stallion, bull and man. These species have long been classified as continuous breeders but evidence is now accumulating to show that although spermatozoa are produced throughout the entire year certain seasonal trends in the rate of spermatogenesis and the degree of fertility are evident. The purpose of this study was to determine the influence of season upon semen quality in the dairy bull.

REVIEW OF LITERATURE

The factors influencing spermatogenic activity have been thoroughly reviewed by Moore (10) but in brief, the testis is regulated by the gonadotopic hormones of the anterior pituitary gland and to some extent by other endocrines, by the amount and quality of light, by environmental and testicular temperatures and by the plane of body nutrition.

Radulescu (11) in Europe and Roux and Hoffman (12) in South Africa concluded that in the ram spermatogenesis is continuous throughout the year. McKenzie and Berliner (8) in an extensive study of semen production of Hampshire and Shropshire rams under Missouri conditions reported that although spermatozoa were produced during all months, definite seasonal trends in semen quality were apparent. Maximum semen quality was observed in the Shropshires from October to January and in the Hampshires from August to January. Seasonal changes were more apparent in the Shropshire rams and very poor semen was produced by the males of this breed during July and August.

Many studies of spermatogenesis, semen production, sperm physiology and fertility have been made in the bovine, Williams (16), Donham *et al.* (2), Lagerlöf (7), Milovanov (9), Davis and Williams (1), Herman and Swanson (5) and others, but none have reported seasonal differences in semen quality.

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Erb, Wilbur and Hilton (3) in a study of the breeding efficiency of the Purdue Dairy Herd from 1920 to 1940 found that maximum efficiency was obtained in May (74.3 per cent) and that the minimum efficiency occurred in August (58.2 per cent). The causes of the seasonal differences were not apparent from the available records and the present study was undertaken in the hope that information on the rôle of season and its influence on the reproductive performance of the dairy bull might be gathered.

MATERIALS AND METHODS

Four Holstein, two Jersey, two Guernsey and one Ayrshire bulls were used in this study. These animals were regular herd sires in the Purdue University Dairy Herd and ranged in age from one to seven years.

The bulls were housed in individual 10×12 foot stalls and had access at will to 12×60 foot exercising pens, although no compulsory exercise was employed. The animals had no access to pasture and were maintained throughout the experiment on a grain ration composed of 200 pounds of yellow corn, 100 pounds of oats, 50 pounds of bran, 50 pounds of old process linseed oil meal, 50 pounds of cottonseed meal, 12 pounds of salt and 100 pounds of bone meal. The grain mixture contained 13.4 per cent crude protein and was fed in sufficient amounts to maintain satisfactory growth of the immature bulls and to maintain all of the animals in "good breeding condition" according to the usual Dairy Husbandry standards. First cutting No. 2 grade alfalfa hay averaging 19 per cent crude protein was fed *ad libitum*.

Semen was collected from all bulls with an artificial vagina once each week and, with a few exceptions, two ejaculates were obtained within a ten-minute interval at each collection period.

The methods of semen evaluation were those which are commonly used in investigations of this type and have been fully described by Weisman (15), Lambert and McKenzie (6), McKenzie and Berliner (8) and others. Semen volume and the initial motility of the spermatozoa were immediately recorded and pH determinations were made with the Beckman pH Meter and the one-drop glass electrode within the first post-collection hour. The semen samples were stored at 40° F. in 4 cc. glass vials fitted with paraffined corks and small portions were withdrawn at 24-hour intervals and examined for motility in a stage incubator at 100° F.

The degree of motility of the spermatozoa was expressed in terms of the following criteria:

0 = No motility.

1 = Less than 20 per cent of the sperm showing progressive motion.

2 = Twenty to 40 per cent of the sperm exhibiting progressive motion but no evidence of waves or eddies in the semen drop.

3 = Forty to 60 per cent of the spermatozoa showing vigorous progressive movement and the formation of slowly moving waves in the semen.

4 = Sixty to 80 per cent of the sperm exhibiting rapidly moving waves showing some dead spermatozoa carried along by the motion of the semen.

5 = Eighty to 100 per cent of the spermatozoa showing rapid, progressive movement. The rapidly moving waves formed by the activity of the sperm show very few dead cells being swept along as inert bodies.

The concentration of the spermatozoa per unit volume of semen was determined with the hemacytometer using the technique which is ordinarily applied for the counting of red blood cells. The total spermatozoa per ejaculate were determined and a total motility rating score was obtained by summation of the individual motility ratings during the entire survival period.

Smears of each ejaculate were made at the time of collection, were air dried, and later stained with eosin. These slides were examined at 440× magnification and the various types of abnormal sperm forms recorded.

The data were analyzed for variance by the methods described by Snedecor (14).

RESULTS

The results of the examination of 879 ejaculates produced by 9 bulls between July 1, 1940, and August 31, 1941, are presented in this study.

Marked individual differences between bulls, and between successive weeks in the same bull, are apparent, and the significance of the variations has been tested. An analysis for variance on all samples collected from four bulls which were in the experiment for at least 12 consecutive months has been performed by the methods described by Snedecor (14). These bulls were normal, young, healthy animals with good breeding records and were maintained under the same system of management throughout the experiment:

Bull	*Age*	*Breed*
10A	1½ years	Holstein
Design	2 years	Jersey
Brampton	4 years	Jersey
Drummer	3 years	Ayrshire

A summary of the factors which were analyzed and the significant variations which were observed is presented in table 1. Significant differences between bulls occurred for each factor analyzed, and, as with other types of physiological studies on small numbers of farm animals, the importance of careful study and analysis of the data is apparent. Highly significant differences occurred between months for each factor except pH, and this showed significant variation at the 5 per cent level. These results suggest that seasonal trends in semen production and quality do occur. The bull-month interaction analysis (table 1) reveals that the concentration of spermatozoa, the numbers of abnormal sperm forms, the survival of spermatozoa,

and the total motility rating show highly significant variations and that volume varied significantly at the 5 per cent level.

The results of an analysis designed to reveal the significant monthly variations from the mean of four bulls are presented in table 2. The data show that semen of consistently inferior quality, when compared with the mean, was produced during the months of July, August and September and that semen of superior quality was obtained during April, May and June.

Although it has been shown in table 2 that significant monthly variations in semen quality occurred (means of 4 bulls) these results do not necessarily indicate individual bull variations. Since too few samples were obtained each month from individual bulls to yield a satisfactory mean the twelve months of the year were grouped as follows: winter (January, February and March); spring (April, May and June); summer (July, August and September); fall (October, November and December). These divisions were made because no appreciable differences in semen quality occurred within the periods, and because these months are the most similar in average daily temperature and humidity.

TABLE 1

Summary of the analyses of variance of the semen characteristics of 4 bulls

Factor analyzed for variance	Source of variation		
	Between bulls	Between months	Bull-month interaction
Initial motility	++	++	−
Volume	++	++	+
Concentration of sperm/mm.^{3}	++	++	++
Total sperm	++	++	−
pH	++	+	−
Abnormal sperm/1000	++	++	++
Survival period	++	++	++
Total motility rating	++	++	++

− = Non-significant.
+ = Significant.
++ = Highly significant.

Volume and initial motility. The seasonal trends of the average semen volume and initial motility of 9 bulls are shown graphically in figure 1. Seven of the 9 bulls produced spermatozoa with the lowest initial motility during the summer months. The variation of 2 of the bulls, Blend and Triumph, may be due to individual differences, although the fact that Blend was started in service in January, 1941, and was used for only limited service during the first 2 months, and that Triumph often exhibited little or no sex desire, may explain the differences observed. The average volume of semen per ejaculate did not show as much variation as initial motility and with one exception (Lad) the average semen volume was least in the summer months.

TABLE 2

*Summary of the significant monthly variations of the semen characteristics of 4 bulls, *, †, ‡, §*

Month	Initial motility		Volume		Conc. of sperm/mm.³		Total sperm		pH		Abnormal sperm		Survival period		Total motility rating	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Jan.	31	4.26	31	3.78	31	804	31	2858	21	7.12 (++)	31	102.4 (+)	31	9.0	31	13.4
Feb.	34	4.21	34	3.42	34	864	34	2566	27	6.84	34	100.3 (+)	34	10.2 (++)	34	14.3 (+)
March	34	3.74	33	3.33	34	754	34	2741	21	6.89	34	119.9	34	9.1	34	12.4
April	43	4.16	43	4.13 (+)	43	1166 (++)	43	4948 (++)	40	6.86	43	104.9	43	10.1 (++)	43	14.7 (++)
May	41	4.29 (+)	39	3.45	39	1194 (++)	39	4224 (++)	34	6.90	39	118.7	39	9.1	39	15.5 (++)
June	43	4.35 (+)	43	3.61	43	1320 (++)	43	4576 (++)	38	6.83	43	103.3 (+)	43	8.9	43	13.2
July—'40 July—'41	63	3.65 (+)	63	2.76 (+)	61	866	61	2534	53	6.76	60	165.1 (++)	37	7.9	37	12.6
August—'40 August—'41	71	3.18 (++)	74	2.52 (++)	74	873	74	2473 (+)	70	6.85	62	165.4 (++)	74	4.4 (++)	74	7.4 (++)
Sept.—'40 Sept.—'41	62	3.55 (++)	60	2.72 (+)	60	760 (+)	60	2031 (+$_T$)	54	6.80	69	164.6 (++)	61	5.0 (++)	58	8.3 (++)
Oct.	42	4.55 (++)	42	3.63	42	693 (+)	42	2580	36	6.83	40	97.2 (++)	42	9.0	42	13.4
Nov.	35	3.89	35	2.71	35	777	35	2269	32	7.13 (++)	35	106.7	35	5.5 (++)	35	8.9 (++)
Dec.	38	4.50 (++)	38	3.57	38	932	38	3475	29	6.83	38	90.9	37	8.8	37	13.6
All months	537	3.94	536	3.21	534	914	534	3039	455	6.87	528	126.6	510	7.7	507	11.7

* + = Significant difference from mean.

† ++ = Highly significant difference from mean.

‡ Least significant mean difference = $t.05\sqrt{VE\left(\frac{1}{N}+\frac{1}{N_2}\right)}$

§ Highly significant mean difference = $\frac{t.01}{t.05}$ × least significant mean difference.

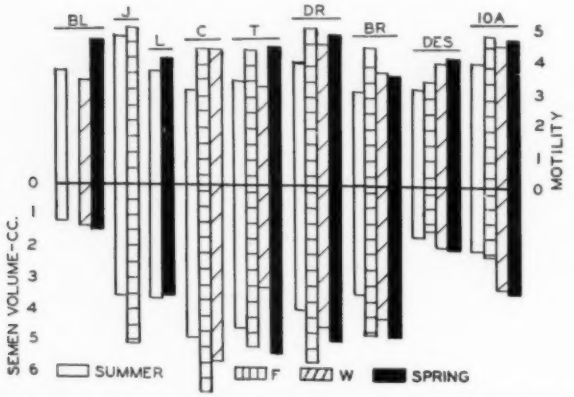

FIG. 1. The effect of season on the average semen volume and average initial sperm motility of individual bulls. Explanation: Bl—Blend; J—Jackie; L—Lad; C—Captain; T—Triumph; Dr—Drummer; Br—Brampton; Des—Design.

Concentration and total spermatozoa. The average number of sperm per cubic millimeter of semen was greater during the spring than in any other season, and the total number of spermatozoa per ejaculate showed the same trend (figure 2).

Hydrogen-ion concentration. As shown in figure 3 the average initial pH of the semen showed little seasonal change in either the same or between different bulls and there were no significant trends.

Abnormal spermatozoa. With the exception of Captain all bulls produced significantly greater numbers of abnormal sperm forms per thousand spermatozoa during the summer months than during any other season. The

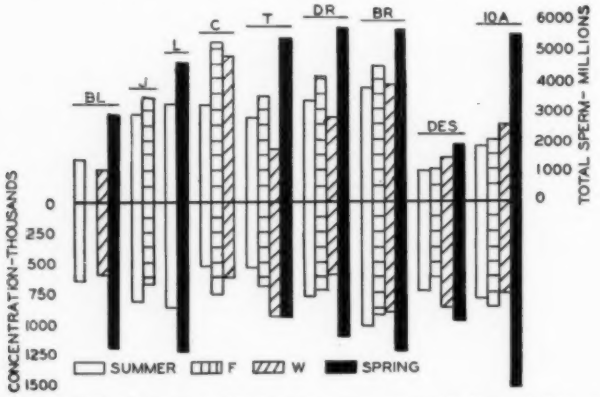

FIG. 2. The effect of season on the average sperm concentration and the average total sperm per ejaculate of individual bulls.

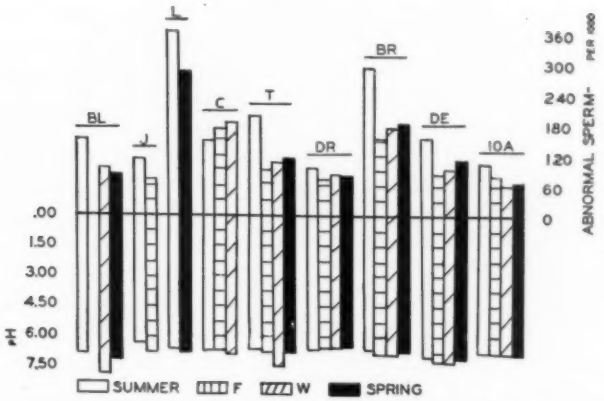

FIG. 3. The effect of season on the average pH and the average numbers of abnormal sperm per thousand spermatozoa of individual bulls.

numbers of abnormal sperm present in semen samples obtained during the fall, winter and spring were highly comparable (figure 3).

Survival period and total motility rating. As shown in figure 4 considerable individual variation was observed in the survival of spermatozoa and in the total motility rating. However, the survival and total motility ratings were usually poorest during the summer months when compared to the fall, winter and spring periods.

Summary of significant seasonal variations. When seasonal comparisons were made by computing the least significant mean differences of individual bulls for all methods of semen evaluation with the exception of pH, certain

TABLE 3

Summary of the significant seasonal variations of 9 individual bulls when all methods of semen evaluation except pH were considered

	Spring and summer		Fall and summer		Winter and summer		Spring and fall		Winter and fall		Spring and winter	
	Sp.	S.	F.	S.	W.	S.	Sp.	F.	W.	F.	Sp.	W.
Total number of comparisons	49	49	49	49	49	49	35	35	42	42	42	42
No. of highly significant comparisons showing production of superior quality semen	31	0	20	0	14	1	11	0	3	2	14	0
No. of significant comparisons showing production of superior quality semen	8	0	3	0	5	2	6	0	1	2	2	0
No. of non-significant comparisons	10	10	26	26	27	27	18	18	34	34	26	26

trends are evident. These data, which are summarized in table 3, show that when spring and summer semen quality were compared, spring semen was superior to that produced during the summer in 39 of 49 comparisons. Spring semen was equal to or superior to that produced during the fall and winter, and the semen of the poorest quality was produced during the summer months.

Temperature as a factor in seasonal spermatogenesis. Although temperature, humidity, and quantity and quality of light vary during the four seasons of the year and although the conditions during the same months of different years are often dissimilar, it is believed that temperature changes

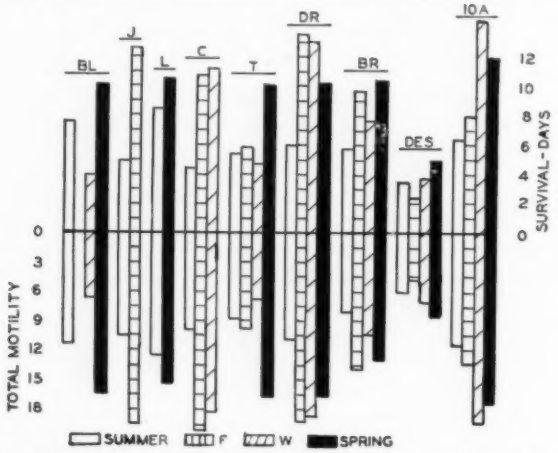

FIG. 4. The effect of season on the average total motility rating and the average survival period of spermatozoa of individual bulls.

are at least partially responsible for the differences in semen quality which were observed.

The relationships between temperature and semen quality for the four bulls which were in the experiment for a complete year are presented in figure 5. Many of the trends in semen production follow the temperature curve rather closely. The average number of abnormal spermatozoa per thousand sperm increased more than 25 per cent during the months of July, August and September and total motility, survival, concentration, initial motility and volume were least at the time the maximum temperatures were observed. Rapid changes in temperature, either up or down, often seemed to be reflected in semen quality, and the fact that the average maximum temperature dropped 23 degrees Fahrenheit during November may have been at least partially responsible for the decreased quality of the semen which was collected during that month.

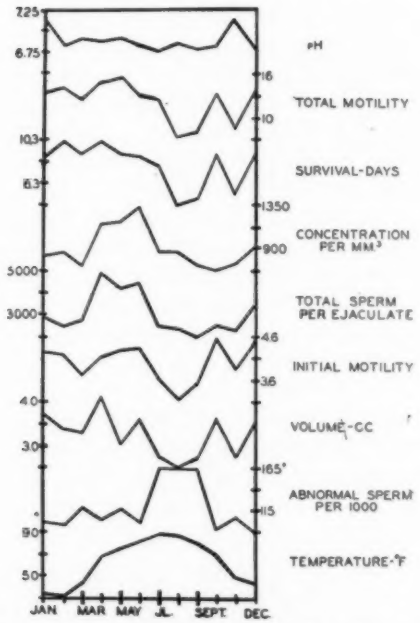

FIG. 5. Summary of the monthly variations in the semen quality of the 4 bulls, Drummer, Brampton, Design and 10A.

DISCUSSION

The causes of sterility and the factors which influence fertility are numerous and at best only partially understood. Sterility is usually easily recognized, for it is manifest by complete reproductive failure whereas fertility is a relative condition and must be expressed in relative terms. Those species which are strictly seasonal breeders are sterile during the non-breeding season, whereas such species as man, the domestic fowl, the horse, the bovine, and others, although classified as continuous breeders, tend to reproduce at different intensities throughout the year.

Although few critical studies of the influence of season upon reproduction in dairy cattle have been made, evidence has been accumulating that such influences do exist. Hammond (5) states that although cows will breed throughout the year the reproductive forces are at a maximum from May to July. Erb *et al.* (3) found breeding efficiency to be maximum during May and June and minimum during July and August, and Seath and Staples (13) of the Louisiana Station subsequently reported that more services per conception were required during the summer months than at any other period of the year.

A study of the reproductive efficiency of the Purdue Dairy Herd between 1920 and 1940 by Erb, Wilbur and Hilton (3) reveals an average breeding efficiency of 58.2 per cent in August as contrasted with 74.3 per cent in May. Although quantitative data were not available in the records of that 20-year period for determining the relative fertility of the males and females involved, it is likely that both sexes were affected. It is interesting to note that the quality of the semen produced by the bulls included in the present study, as determined by the laboratory methods described, was significantly superior during April, May and June and significantly inferior during July, August and September. Since the management and plane of nutrition of the bulls were similar throughout the experimental period it is concluded that the changes observed were the result of those factors which characterize the seasons—temperature, light, relative humidity and other general or obscure atmospheric factors.

Seasonal changes in semen quality of the bulls were not as striking as those which McKenzie and Berliner (8) have reported for Shropshire rams maintained under Missouri conditions. For example, the maximum average number of abnormal sperm forms per thousand spermatozoa was 165 in August in the bulls in contrast with more than 700 per thousand in Shropshire rams. Whereas the semen of this particular breed of rams might be considered relatively infertile during August, the semen produced by the bulls during the corresponding period might be described as of lowered quality when compared with the annual mean.

The experiment was not designed to determine the specific influences of temperature, light or humidity but it is believed that environmental temperature was undoubtedly of considerable importance. Many workers, as reviewed by Moore, (10) have demonstrated the deleterious effects of elevated temperatures upon spermatogenesis in mammals. The direct application of heat to the testis, the insulation of the scrotum, the replacement of the testes in the abdominal cavity, or a continued febrile condition, cause partial or complete inhibition of spermatogenesis. The increased rate of respiration and uneasiness which is characteristic of cattle and other farm animals, during periods of prolonged hot, humid weather is an indication that the regulation of body temperature is difficult and it would not be considered unusual if certain body processes such as semen production, were interfered with. The fact that McKenzie and Berliner (8) were able to decrease semen quality during the winter months by placing a group of rams in a warm, humid room is an indication that environment can exert a marked influence upon spermatogenesis in the normal intact male. Whether these effects are directly upon the testis, the hypophysis and/or other endocrines remain at present unexplained.

SUMMARY

1. Analyses of variance in various characteristics of semen production between bulls and between months reveal highly significant differences between bulls and between months for all factors studied except pH.

2. The average semen volume was least in July, August and September.

3. The average initial motility was least in July, August and September.

4. The average concentration of spermatozoa and total sperm per ejaculate was maximum during April, May and June.

5. The average period of sperm survival was least in August, and lower in July, September and November than during any other months.

6. The average number of abnormal spermatozoa was 25 per cent greater during July, August and September than during the next highest month of the year.

7. No significant seasonal variations in pH were observed.

8. The quality of the semen produced by the bulls in this study was significantly superior during the spring and significantly inferior during the summer. The semen produced during the fall and winter months did not vary significantly from the mean.

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A COMPARATIVE STUDY OF THE FROST LITTLE PLATE AND STANDARD PLATE METHODS FOR THE BACTERIOLOGICAL EXAMINATION OF MILK, CREAM, AND ICE CREAM*

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In 1915 Frost (1) presented a technique for making a rapid microscopic colony count of bacteria in milk, which has since been called the Frost little plate method. A detailed procedure was published by him in 1921 (5). Frost (2, 3, 4) and others (6, 8) have made comparative studies of the little plate and standard plating procedure and reported a good agreement between bacteria counts of milk obtained by these two procedures. However, considering the lack of any published reports, the little plate method for determining bacteria counts of milk appears to have been in disuse since 1922. Johns (7) adapted the method for making yeast and mold counts of butter.

The "old" standard nutrient agar was used in the above-mentioned studies. This medium was not a highly nutritive one; therefore Frost recommended a minimum three- or four-hour incubation period for milk in which the bacteria had been actively growing and a minimum eight- or nine-hour incubation period for both low-count milk and milk that had been recently pasteurized. In July of 1939 the American Public Health Association replaced the above agar with the more nutritive tryptone-glucose-extract-milk agar. This change and the fact that most milk plants, creameries, and health departments now have microscopes available, suggested the possibility that the Frost little plate method may be extremely valuable to milk plant operators and health officials in their milk control work insofar as the speed of determining the numbers of living bacteria in milk, cream, and ice cream is concerned. Accordingly, this study of the Frost little plate was made, employing the tryptone-glucose-extract agar to determine the bacteria count of milk, cream, and ice cream.

METHOD

Milk, cream, and ice cream samples were examined for bacteria count by both the Frost little plate (incubated in moist chamber at 37° C.) and

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* Editor's Note: Because of the present limited supply of agar for bacteriological purposes this report is of particular timely interest.

standard plate methods (48 hours of incubation at 37° C.). The milk samples included raw, pasteurized, homogenized, and chocolate milk. Both coffee and whipping cream were similarly checked. All types of ice cream were included in this study. The medium used in determining the standard plate count was the tryptone-glucose-extract-milk agar, while the same medium without adding skimmilk was used in the Frost little plate count.

RESULTS AND DISCUSSION

A. *Milk and cream.* In presenting his method, Frost suggested a variable incubation period depending upon the history of the sample, and that the little plates made from milk with a low count or recently pasteurized milk should be given a long incubation period while those made from milk in which the bacteria had been actively growing required only a short incubation time. This is highly unsatisfactory from a routine standpoint since it depends too greatly upon the judgment of the technician. This study was made, employing tryptone-glucose-extract agar, to determine the actual hours of incubation required of the Frost little plate to yield a count comparable with that obtained by the standard plate method.

The results of three raw and three pasteurized milk samples with both high and low bacteria counts are presented in table 1; these are representative of many samples examined. In each case, the four-hour period of incubation of the Frost little plates yielded similar counts to those obtained upon 48 hours of incubation in the standard plate procedure. The data

TABLE 1

A comparison of the bacteria counts obtained in three raw and three pasteurized milk samples upon various hours of incubation of the Frost little plate with the standard plate count

Hours of incubation of Frost little plates	Raw milk			Pasteurized milk		
	1	2	3	4	5	6
	Standard plate count per cc. of milk					
	5,500	20,000	480,000	500	5,000	40,000
	Frost little plate count per cc. of milk					
1	1,000	2,500	30,000	50	100	500
2	3,000	10,000	126,000	200	1,000	10,000
3	5,000	20,000	294,000	500	5,000	30,000
4	**7,000**	**18,000**	**400,000**	**600**	**6,000**	**42,000**
5	7,000	20,000	400,000	600	8,000	35,000
6	6,000	20,000	420,000	500	5,000	50,000
7	6,000	18,000	420,000	700	5,000	40,000
8	7,000	18,000	420,000	700	7,000	50,000
9	7,000	20,000	400,000	600	7,000	50,000
10	7,000	23,000	420,000	500	5,000	40,000
11	7,000	23,000	420,000	600	7,000	40,000
12	7,000	23,000	400,000	600	7,000	42,000
18	7,000	20,000	400,000	600	7,000	42,000
24	7,000	20,000	400,000	600	7,000	38,000

further show that the little plates may be incubated for periods as long as 24 hours without materially affecting the bacteria count. A four-hour period of incubation in a moist chamber of 37° C. appears to be sufficient incubation time for the Frost little plates in determining bacteria counts of milk and cream.

The presence of chocolate particles may be confusing to the inexperienced technician in the examination of some chocolate milk. This can be largely corrected by making a 1 to 10 or 1 to 100 dilution of the chocolate milk before preparing the little plates. The count obtained must then be multiplied by this dilution to obtain the total number of living bacteria present.

A series of 445 samples was checked for bacteria count by both the Frost little plate and the standard plate method. The data are summarized in table 2. Owing to the number of samples involved, the actual count of each sample is not given, but the bacteria counts obtained are grouped in convenient classes. In considering the classes selected it is obvious that a sample having a standard plate bacteria count of 9,000 and a count of 11,000 on the Frost little plate would be placed into two different classes. Yet from a practical standpoint the two bacteria counts compare very favorably one with the other. The bacteria counts obtained by the two methods compared favorably. This is indicated by the majority of samples belonging to the same bacteria-count class of both methods. The remaining few having slightly higher or slightly lower counts. In no case was there a marked difference in bacteria counts of a sample as determined by the Frost little plate and standard plate methods. In our opinion, the Frost little plate method will not replace the direct microscopic count in the examination of raw producer milk samples, but its use will result in a significant saving of time and materials in the determination of the number of living bacteria present in pasteurized milk and cream.

The bacteria counts of 10 samples of pasteurized milk, obtained by standard plate, Frost little plate, and the direct microscopic methods, are presented in table 3. Samples 1 to 5 inclusive yielded comparable low bacteria counts by all three methods, while samples 6 and 7 had high direct microscopic counts but low counts as determined by both cultural methods. Thermoduric bacteria were present in large numbers in samples 8 to 10 inclusive, as demonstrated by the close agreement of bacteria counts obtained by all three methods. Since both the living and dead bacteria may be stained and counted in the direct microscopic count of milk, this examination cannot be relied upon to give an accurate indication of the numbers of living bacteria in pasteurized milk. To determine the living bacterial content of pasteurized milk or cream, one of the cultural methods must be used. A saving of time will result if the Frost little plate method, with its four-hour incubation period, is used instead of the 48 hour incubation in the standard plate procedure.

TABLE 2

A summary of the standard plate count and Frost little plate count of 445 milk samples; 321 were raw producer milk samples while the remaining 124 included chocolate milk, raw and pasteurized milk, homogenized milk, and coffee and whipping cream

Standard count* plate		Frost little plate count*											
		Less than 1T	1T–10T	10T–25T	25T–50T	50T–75T	75T–100T	100T–250T	250T–500T	500T–750T	750T–1M	1M–2M	Over 2M
	Number	62	168	70	31	12	13	23	16	12	6	14	18
Less than 1T	55	31	18	6									
1T– 10T	165	28	124	13									
10T– 25T	81	3	25	42	11								
25T– 50T	21		1	6	11	3							
50T– 75T	27			3	7	7	7	3					
75T–100T	6				1		3	2					
100T–250T	23				1	2	3	15	1	1			
250T–500T	14							2	7	3	1	1	
500T–750T	13							1	7	2		2	1
750T–1M	5								1	1	3		
1M–2M	17									4	2	8	3
Over 2M	18									1		3	14

* T = thousand, M = million.

TABLE 3

A comparison of counts of pasteurized milk, both with and without thermoduric bacteria, obtained by the standard plate, Frost little plate, and direct microscopic methods

	Bacteria count per cc. of milk		
	Standard plate	Frost little plate	Direct microscopic (clump count)
	Thermoduric bacteria absent		
1	1,500	850	5,000
2	500	425	5,000
3	800	560	5,000
4	4,000	3,500	5,000
5	3,000	3,500	5,000
6	10,000	8,500	60,000
7	8,000	12,000	120,000
	Thermoduric bacteria present		
8	55,000	42,500	40,000
9	90,000	130,000	140,000
10	110,000	130,000	120,000

B. *Ice cream.* A comparison was made of the standard plate count of ice cream with the bacteria counts obtained upon varying periods of incubation of the Frost little plate. The results of six samples are presented in table 4 and indicate that an eight-hour minimum period of incubation of the Frost little plate yielded results that were essentially the same as the standard plate count. All Frost little plates were incubated eight hours for subsequent bacteria counts of ice cream. If not convenient to remove the little plates at eight hours, they may be incubated as long as 24 hours with-

TABLE 4

A comparison of the standard plate count of six ice cream samples with the counts obtained upon various hours of incubation of the Frost little plate

Hours of incubation of Frost little plates	1	2	3	4	5	6
	Standard plate count per gram of ice cream					
	200	350	4,800	350,000	630,000	10,000,000
	Frost little plate count per gram of ice cream					
4	50	200	300	200,000	400,000	6,000,000
5	50	250	500	200,000	480,000	8,000,000
6	50	350	800	300,000	450,000	8,000,000
7	50	350	1,800	400,000	600,000	10,000,000
8	**100**	**500**	**4,000**	**400,000**	**750,000**	**12,000,000**
9	100	400	4,000	350,000	700,000	10,000,000
10	150	500	5,000	350,000	700,000	10,000,000
11	100	500	4,000	400,000	650,000	12,000,000
12	200	450	6,000	400,000	700,000	10,000,000
13	200	500	4,500	400,000	700,000	10,000,000
14	100	400	4,000	400,000	700,000	10,000,000
15	150	550	6,000	400,000	700,000	12,000,000
20	150	450	6,000	350,000	800,000	12,000,000
24	100	400	4,000	350,000	700,000	10,000,000

out affecting the results. The colonies were of sufficient size after eight hours of incubation to be differentiated from strawberry seeds, nut fragments, and chocolate particles in these flavors of ice cream. The technician who is not familiar with the microscopic appearance of strawberry seeds, nut fragments and chocolate particles may experience some difficulty in differentiating between these particles and colonies. In case of doubt, the use of higher powered objectives will reveal individual bacteria along the edge of colonies. Ice creams containing particulate matter may be diluted 1 to 10 or 1 to 100 before preparing the Frost little plates, thus reducing the amount of foreign material in the little plate. In those cases, the Frost little plate count must be multiplied by the dilution made in order to obtain the total number of viable bacteria present.

One hundred and sixty-five samples of commercially prepared ice cream were checked for bacteria count by the Frost little plate and standard plate methods. A summary of the counts obtained is presented in table 5. A study of these data indicates that the counts obtained by the two methods compare very favorably. The Frost little plate may be substituted for the standard plate method for determining the living bacteria count of ice cream. Again, as in the case of milk, the saving of time in obtaining the little plate count is of decided practical importance to both ice cream manufacturers and health officials.

FROST LITTLE PLATE METHOD FOR MAKING A MICROSCOPIC COLONY COUNT OF MILK, CREAM, AND ICE CREAM

1. Place a test tube rack, containing enough sterile tubes for the number of samples to be tested, into a water bath at 45 to 50° C.
2. Place 0.5 cc. of milk into a test tube in the water bath.

   (a) In the examination of ice cream, weigh 0.5 gram into the sterile tubes in step 1 prior to placing the tubes into the water bath. Keep the tubes in a pan of ice water or a refrigerator while weighing the remaining samples.

   (b) When examining chocolate milk or strawberry, nut and chocolate ice cream, make a 1 to 10 or 1 to 100 dilution before proceeding with step 2, thus reducing the number of particles in the preparation. The final count must be multiplied by this dilution when made.

   (c) Do not allow more than 15 minutes between step 2 and completing step 4.
3. Add 0.5 cc. of sterile tryptone-glucose-extract agar, cooled to 50° C., into each tube in the water bath, and mix by shaking.
4. Using a sterile pipette place 0.1 cc. of the agar milk mixture onto a sterilized microscopic slide (sterilized in the naked flame) and spread evenly over an area of four square centimeters with the tip of the pipette. (Two or three such films can be put on the ordinary microscope slide.)

TABLE 5

A comparison of the standard plate count with the Frost little plate count of 165 ice cream samples

Standard plate count*		Frost little plate count per gram of ice cream											
		Less than 1T	1T–10T	10T–25T	25T–50T	50T–75T	75T–100T	100T–250T	250T–500T	500T–750T	750T–1M	1M–2M	Over 2M
	Number	11	71	32	14	10	1	8	10	3	0	2	3
Less than 1T	9	5	4										
1T– 10T	80	6	66	8									
10T– 25T	29		1	23	5								
25T– 50T	14				9	5							
50T– 75T	6			1		4	1						
75T–100T	3							3					
100T–250T	9					1		4	4				
250T–500T	8							1	6	1			
500T–750T	3									2		1	
750T–1M	1											1	
1M–2M	1												1
Over 2M	2												2

* T = thousand, M = million.

5. The little plate is allowed to harden and then placed into a moist chamber at 37° C. for a minimum of *four hours of incubation for milk and cream,* or a minimum of *eight hours of incubation for ice cream.* (A moist chamber can be made out of any container with a tight-fitting cover by filling the container approximately ¾ full of water. A wire platform must be built above the level of the water to hold the slides during incubation. The proper temperature of bath is maintained by leaving the moist chamber in the 37° C. incubator at all times.)

6. After incubation the plates are dried at a temperature slightly under 100° C. (Agar should not melt; plates should be dried rather slowly to prevent cracking the medium.)

7. Stain with a methylene blue solution. (To prepare add 10 cc. of a saturated alcoholic solution to 90 cc. of water.) This should stain the colonies deeply and leave a faint blue background.

8. Wash slides to remove excess stain being careful not to wash the film off the slides (best results are obtained by allowing the water to hit the reverse side of slide—enough water will flow over the preparation to remove the excess stain). Dry preparations.

9. Examination: Use lower power (if few colonies), high dry power or oil immersion (if many colonies) to determine the average number of colonies per field (Count *50 fields* when few colonies are present, and *10 fields* when many colonies are present.) and note bacteria count by referring to the table:

TABLE 6

FROST LITTLE PLATE COUNTS

(This table can be used with all miscroscopes having a factor of 300,000 in the direct microscopic counting of bacteria in milk)

	Colonies in fields	Bacteria per cc.		Colonies in fields	Bacteria per cc.		Colonies in fields	Bacteria per cc.
Low Power Objective	1	50 = 50	High Dry Objective	1	1.6 = 30,000	Oil Immersion Objective	2	1 = 480,000
	1	25 = 100		1	1 = 42,000		3	1 = 720,000
	1	12.5 = 200		2	1 = 84,000		4	1 = 960,000
	1	5 = 500		3	1 = 126,000		5	1 = 1,200,000
	1	2.5 = 1,000		4	1 = 168,000		6	1 = 1,440,000
	1	1 = 2,500		5	1 = 210,000		7	1 = 1,680,000
	2	1 = 5,000		6	1 = 252,000		8	1 = 1,920,000
	4	1 = 10,000		7	1 = 294,000		9	1 = 2,160,000
	6	1 = 15,000		8	1 = 336,000		10	1 = 2,400,000
	8	1 = 20,000		9	1 = 378,000		15	1 = 3,600,000
	10	1 = 25,000		10	1 = 420,000		20	1 = 4,800,000

SUMMARY

The incubation of Frost little plates at 37° C. in a moist chamber for four hours yielded bacteria colony counts of milk and cream comparable to the standard plate count. The chocolate particles of some chocolate milk may confuse the technician unless a 1 to 10 or 1 to 100 dilution is made before preparing the little plate.

Comparable counts were obtained upon examination of ice cream by the standard plate and Frost little plate methods when the little plates were incubated for a minimum period of eight hours at 37° C. in a moist chamber. Ice cream containing seeds, nuts, or chocolate particles may be diluted as in the case of chocolate milk before preparing the little plates.

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ABSTRACTS OF LITERATURE

BOOK REVIEWS

510. Industrial Waste Treatment Practice. E. F. ELDRIDGE, Research Associate, Eng. Expt. Sta., Mich. State College. McGraw-Hill Book Co., Inc., New York. 1942.

This book is the culmination of years of work on the part of the author in the field of industrial waste treatment and disposal. Many of the problems which arise in connection with the various industrial wastes are of very diversified nature and become complicated when the wastes must be handled through domestic sewage systems. More pressure is being put upon industrial plants to diminish or to entirely eliminate the pollution of bodies of water which are used either as sources of municipal water supplies or for public recreational purposes. The dairy industry is pointed out to be one of the outstanding sources of wastes from its milk processing and manufacturing plants. For example, a milk condensery or a cheese factory may have a waste disposal load equivalent to that of the sewage from a population of 1,500 to 3,000, the number of people in a small town. On the other hand, the combined effluents of a large city's milk plants and ice cream plants can be the source of a heavy waste load on the municipal sewage disposal system.

The chapter listing is as follows: I. Stream Pollution, II. Characteristics of Industrial Wastes, III. Standard Treatment Methods, Structures, and Equipment, IV. Wastes from the Beet-Sugar-Industry, V. Milk Products-Factory Wastes, VI. Canning-Factory Wastes, VII. Tannery Wastes, VIII. Pulp-and-Paper-Mill Wastes, IX. Textile Wastes, X. Meat Packing and Slaughter-House Wastes, XI. Laundry Wastes, XII. Wastes from the Metal Industries, XIII. Gas- and Coke-Plant Wastes, and Other Phenolic Wastes, XIV. Wastes from Fermentation Industries, XV. Wastes from Oil Fields and Refineries, XVI. Treatment of Combined Industrial Waste and Domestic Sewage, XVII. Methods of Analysis for Industrial Wastes.

In Chapter V, Milk-Products-Factory Wastes, the subjects taken up are, Manufacturing Processes and Source of Wastes, Composition of Milk Waste, Preventing Milk Losses, Segregation of Clean Water, Volume and Strength of Waste, Treatment Processes, Standard Biological Filter, Continuous Recirculating Filter, Fill and Draw Recirculating Filter, Biochemical Process, Mallory Process.

This book is recommended as a reference for dairy manufactures and dairy technology students, and to dairy plant executives and milk sanitarians as an authoritative source of information on dairy waste treatment and disposal. L.M.D.

511. The Physiology of Domestic Animals, 5th Edition. H. H. DUKES. Comstock Publishing Company, Inc., Ithca, N. Y. 721 pages, illustrated, $6.00.

Readers of the JOURNAL OF DAIRY SCIENCE who are interested in the production phases of the industry will be interested in learning of the recent revision of this well known and widely used textbook of animal physiology.

We are living in a dynamic world. To be of greatest usefulness textbook recordings of scientific progress must be constantly revised. In recognition of this need "The Physiology of Domestic Animals," first published in 1933, is now in its 5th Edition. During this period, not only has the book been kept up to date but the scope of subject matter covered has been expanded.

For the present edition the entire book has been revised and a good part of it completely rewritten. A number of subject matter additions have been made and the amount of applied material increased. These changes enhance its usefulness as a college text and reference work. T.S.S.

BACTERIOLOGY

512. Inhibition by Phospholipids of the Action of Synthetic Detergents on Bacteria. Z. BAKER, R. W. HARRISON AND BENJAMIN F. MILLER, Univ. Chicago, Chicago, Ill. Jour. Expt. Med., *74*, No. 6: 621–637. Dec. 1, 1941.

This investigation suggests that detergents may be responsible for denaturizing the bacterial proteins or changing the cell membrane in such a way that it affects the metabolism of the bacterial cell.

The addition of phospholipids (lecithin, cephalin, and sphingomyelin) to synthetic anionic and cationic detergents prevents the inhibition of bacterial metabolism.

"The phospholipids must be added either before or simultaneously with the detergent. Addition after the detergent is without effect. Bacteria still exhibit this phenomenon after they have been exposed to the phospholipid and thoroughly washed."

Bactericidal compounds isolated from soil bacteria in the presence of phospholipids show an inhibition of bacterial metabolism. H.H.W.

513. The Bactericidal Action of Synthetic Detergents. ZELMA BAKER, R. W. HARRISON AND BENJAMIN F. MILLER, Univ. Chicago, Chicago, Ill. Jour. Expt. Med., *74*, No. 6: 611–620. Dec. 1, 1941.

A study of the type, structure, action on bacterial metabolism, and germicidal properties of 20 cationic and anionic detergents were studied on 6 Gram-positive and 6 Gram-negative micro-organisms.

Zephiran, Phemerol, Retarder LA, Emulsol 605, Catol, Emulsol, 607,

Emulsol 660B, Damol and Emulsol 609 are trade names of cationic detergents. Cetyl sulfate, sodium myristyl-sulfate, Duponol LS, Tergitol-8, Triton W-30, Igepon T, Tergitol-7 and Tergitol-4 belong to the class of anionic detergents.

The selected detergents were used in concentrations of 1:1000, 1:3000, 1:6000 and 1:30,000 at pH 7.0 and with time intervals ranging from 10 to 90 minutes exposure of the various test organisms.

The cationic detergents showed a greater germicidal action on the Gram-positive organisms than on the Gram-negative bacteria.

A relationship appears to exist between the bactericidal action and the chemical structure of the detergent. H.H.W.

BREEDING

514. The Incidence of Right and Left Horn Pregnancies in Dairy and Beef Cattle. M. ERDHEIM, U.S.B.A.I., Chicago, Ill. Jour. Amer. Vet. Med. Assn., *100,* No. 781: 343. Apr., 1942.

Observations were made on a total of 3,824 pregnant uteri on the post-mortem table. 1,506 were from dairy cattle and 2,318 from beef breeds.

"In the dairy group, the ratio of right to left pregnancies was 2:1 and in the beef breeds approximately equal.

"There was one pair of twins to every 89 pregnancies in the dairy groups and one in every 126 for the beef cattle.

"Of the 17 twin pregnancies in both of the dairy groups studied, 15 were bilateral and 2 unilateral. In the beef breeds 16 of the twins were bilateral and 3 unilateral." S.A.F.

BUTTER

515. Diacetyl and Acetylmethylcarbinol Production in the Manufacture of Unsalted Butter. T. I. HEDRICK AND B. W. HAMMER. Iowa Agr. Expt. Sta. Res. Bul. *301.* May, 1942.

During the ripening of sweet or neutralized sour cream in laboratory and semi-commercial trials there were some irregularities in the effects of various factors on the diacetyl and acetylmethylcarbinol contents of the cream, but generally the contents were increased by an increase in the acidity to which the cream was ripened, by addition of small amounts of citric acid to the cream and by agitation (shaking in the laboratory trials and revolving the coils in the semi-commercial trials) during the ripening. In some trials the contents were greatly influenced by the use of certain butter cultures, while in other trials they were not.

In general, as the diacetyl contents increased in the ripening cream the acetylmethylcarbinol contents also increased, but there were variations from

this relationship. The occasional decreases in diacetyl contents often were accompanied by increases in acetylmethycarbinol contents.

Some of the ripening procedures used with the cream were beneficial from the standpoint of score of the butter under certain holding conditions. These procedures included development of higher acidities in the cream, addition of citric acid to the cream and agitation of the cream during ripening.

With the semi-commercial churnings the ratios of the diacetyl contents of the cream to those of the corresponding butter were: minimum 1:0.142; maximum 1:0.709; and average 1:0.352. With acetylmethylcarbinol the ratios were 1:0.059; 1:0.683; and 1:0.217, respectively.

The diacetyl or acetylmethylcarbinol contents of the lots of butter in a series sometimes did not follow the same order as the contents of the lots of cream from which the butter was churned; the irregularities were of various types.

With the holding of butter 1 week at 36° to 40° F., 3 days at 60° F. plus 4 days at 36° to 40° F. or 1 month at 36° to 40° F., both increases and decreases in the diacetyl and acetylmethylcarbinol contents occurred. With each compound under each set of conditions the increases were more numerous than the decreases. After holding 3 days at 60° F. plus 4 days at 36° to 40° F., the diacetyl contents were higher in 75% of the comparisons, and the acetylmethylcarbinol contents were higher in 73% of the comparisons than in corresponding butter held in 1 week at 36° to 40° F.

Author's Summary

516. Studies on Surface Taint Butter. H. WOLOCHOW AND H. R. THORNTON, Univ. Alberta, AND E. G. HOOD, Dom. Dept. of Agr., Ottawa. **IV. Distribution and Taxonomy of *Pseudomonas putrefaciens*.** Sci. Agr., *22*, No. 8: 461. 1942.

The literature on surface taint butter is summarized and indicates that *Pseudomonas putrefaciens* is widely distributed. It is a soil and water type. There is some confusion as to the taxonomy of this species. The authors state that this organism should be placed in the family Pseudomonadaceae, Tribe Pseudomonadeae.

V. The Growth of *Pseudomonas putrefaciens* in Butter. Sci. Agr., *22*, No. 9: 552. 1942.

There is much evidence that Gram-negative, rod-shaped, proteolytic bacteria which grow at low temperatures are involved in the production of surface taint butter. Large numbers of organisms must be present in the butter, however, if the organisms themselves are the cause of the defect, and the question is raised as to whether or not well worked commercial butters contain these large numbers.

In producing surface taint butter experimentally relatively large inocula

had to be added to the cream or to the unworked butter. This also applied to the initiation of growth in tubes of litmus milk.

The numbers of bacteria in commercial surface taint butters were higher than in normal commercial butters but the surface taint producing organisms constituted only small minority populations in the defective samples. In commercial surface taint butters total counts ranged from less than 100 to more than 6,000,000. These numbers do not appear to be sufficiently large to account for surface taint defect on the basis of cell count.

The numbers of organisms in 5 inoculated-cream butters were determined at intervals up to 23 days, the butter being held at 10–15° C. In most of these cases the counts increased, the maximum numbers ranging from 10–17 million organisms per gram. Between 40 and 100 per cent of these were *Ps. putrefaciens.*

VI. Other Bacterial Species as Causal Agents. *Flavobacterium maloloris* (n. sp.). Sci. Agr., *22*, No. 10: 637. June, 1942.

Among 2500 random bacterial isolations there were 5 of a yellow-pigmented organism which produced surface taint in experimental butter and a sweaty-feet odor when grown in skim milk. The morphology and cultural characteristics of the organism are presented. It is a rod with rounded ends, occurs singly or in pairs, is Gram-negative, non-spore-forming and non-motile. On all media a yellow or yellow-orange color was produced. The organisms were highly proteolytic in skim milk and hydrolyzed starch. Glucose, sucrose, maltose or lactose did not appear to be utilized. The tentative name *Flavobacterium maloloris* is suggested for the species.

The ability of *Pseudomonas fluorescens* to produce surface taint was also investigated. Seven cultures of this species were used in 20 experimental butters some of which developed a surface taint or questionable surface taint 24 hours after churning. Within a further 24 hours these butters graded rancid. It appears that this organism is not a major cause of surface taint. O.R.I.

517. Influence of Method of Separation on Mold Content of Cream. P. R. Elliker and W. H. Brown, Purdue Univ., Lafayette, Ind. Natl. Butter and Cheese Jour., *33*, No. 6: 10. June, 1942.

This experimental study was made to evaluate various methods of separating cream in terms of their effects upon the mold content and quality of the cream.

"Centrifugal separation resulted in lower mold content than did water-dilution and shallow pan separation when cream obtained by these methods was stored at 60° and 80° F. for four and seven day periods.

"When the fresh milk contained a comparatively high number of molds, centrifugal separation removed approximately 90% from both the cream and skim milk.

"Water-dilution and shallow pan separation tended to concentrate molds in the cream. This was apparently due to the effect of the fat globules which, as they rose, carried molds with them to the cream layer.

"Centrifugal separation with a clean centrifugal separator was superior to gravity separation both from standpoint of efficiency of separation and general quality of cream produced." W.V.P.

518. Propionate Salts as Mold Inhibitor. ANONYMOUS. Natl. Butter and Cheese Jour., *33*, No. 6: 16. June, 1942.

Propionate salts can be used to increase 2 or 3 times the mold-free life of butter and cheese. Parchment paper manufacturers make an impregnated paper but when butter is "wet-wrapped" the parchment is soaked in a solution containing 20 oz. of propionate salt per gallon of water. In cream and cottage cheese the salts may be added directly to the cheese at the rate of two to two and one-half ounces per 100 pounds of cheese.* Cheese such as Cheddar when sliced for distribution in stores may be immersed for 15 seconds in a solution of the inhibitor (proper concentration is not indicated) to increase the mold-free life of the cheese 3 to 4 times. W.V.P.

519. Advice on Neutralization. S. T. COULTER, Univ. Minn., Minneapolis. Am. Butter Rev., *3*, No. 12: 432–434. 1941.

Cream containing .17 to .18% acidity should be neutralized to reduce loss of fat in the buttermilk, to secure uniformity of taste, and to improve keeping quality. If starter is to be used acidity should be reduced to 0.1%; if not, to 0.12%. If acidity is higher pH is a better criterion by which to judge the degree of neutralization. For salted butter enough neutralizer should be added that the butter sera falls within the range of pH 6.6 to 7.0. If caustic soda is used it should be added in 5% solution, cold, and to the cream when it is no warmer than 80° F. Sodium sesquicarbonate has proved itself an excellent neutralizer, sodium bicarbonate is apt to give a soda taste, and limes, athough excellent, cause greater fat losses in the buttermilk. P.S.L.

CHEESE

520. Factors Affecting Mold Content and Quality of Cream. P. R. ELLIKER AND W. H. BROWN. Purdue Agr. Expt. Sta. Bul. 465. Jan., 1942.

The results obtained indicate that use of clean utensils and a storage temperature of 60° to 65° F. will insure satisfactorily low mold growth in cream over a storage period of 4 days. Temperatures as high as 70° F. may be employed over a 4-day period if utensils are kept scrupulously clean and milk or cream protected from contamination with dust and dirt. Delivery

* Abstractor's Note: Federal definitions require labeling the package when these salts are so used.

at least twice a week during colder months and three times a week during warmer months of the year is recommended. Where initial contamination of cream is high, excessive growth of molds may occur in as little as 2 days.

The method of separation of cream on the farm is an important factor (along with sanitation, time of storage, and temperature of storage) affecting mold content and quality of cream. Centrifugal separation removed a considerable portion of the mold growth from cream, but gravity separation tended to concentrate molds in the cream layer. Gravity separators also present problems in cooling and contamination of cream from water used in water dilution separation.

Twice-daily agitation of stored cream tends to retard mold growth and encourage development of yeasts. It is not recommended. On the basis of results obtained, it is recommended that fresh, cooled cream be added to stored cream by layering it over the surface of the older cream. A relationship was shown between low fat content and high mold and also small size shipments and high mold content in typical commercial cream samples. The factors entering into this relationship are discussed briefly. Pure cultures of *Oospora lactis* developed best when the culture medium was adjusted to pH values of 5.0 to 8.0. Definite inhibition of growth occurred at pH values below 5.0. P.R.E.

521. Conditions Necessary for Maintaining Quality of Year-Old Vacuum-canned Cheddar Cheese. N. S. GOLDING, Wash. Agr. Expt. Sta., Pullman. Natl. Butter and Cheese Jour., *33*, No. 7: 10. July, 1942.

Measurements were made of the changes in vacuum or pressure and quality of American Cheddar cheese ripened in cans in cool storage for over a year and then held at temperatures to simulate conditions in store or household. Changes in vacuum or pressure were determined by measuring the vacuum on the outside end of the sealed can necessary to raise the lid. Actual vacuum or pressure was then calculated by referring to a similar measurement made on an unsealed can. Six makes of year-old cheese were used. Cans of cheese from each make were stored for 50 days and observed. The data show that high-quality, year-old, vacuum-canned American Cheddar cheese should be held at 52° F. or below to maintain quality. If held at about 70° F. gas is developed and quality deteriorates. Gas developed faster in the latter half of the 50-day storage period. W.V.P.

DISEASE

522. Physiologic and Metabolic Aspects of Acetonemia in Cattle. M. H. ROEPKE, Univ. Minn. Jour. Amer. Vet. Med. Assn., *100*, No. 782: 411. May, 1942.

The article is a summary of recent findings as to the pathology and physi-

ology relating to acetonemia together with a discussion of the value and limitations of the Ross test, the usual diagnostic test using nitroprusside as the diagnostic agent.

Pathologically, the severe form of the disease usually occurs up to six weeks post-partum in high-producing cows during the winter months. Severity of symptoms usually follows the degree of hypoglycemia, but does not parallel the blood and urine ketone concentrations. Fatty livers are a frequent post-mortem finding in severe cases.

Most conditions causing a cow to go off feed will produce a secondary ketosis and a positive Ross test, while a primary ketosis with clinical symptoms, blood ketone values above 20 mg. per cent, and urine ketones above 100 mg. per cent, is the exception and occurs when blood sugar values are one-half normal or less. Diagnosis is more accurate when the urine for the test is diluted 1 : 10 and still gives a strong reaction.

Fundamental causes of acetonemia may possibly be lowered liver function, inadequate pituitary stimulation, or lowered carbohydrate intake on winter rations. S.A.F.

523. The Value of Intravenous Calcium Chloride and Glucose in Uterine Inertia of Cows. H. C. Smith, Stillwater, Okla. Jour. Amer. Vet. Med. Assn., *100*, No. 780: 232. March, 1942.

Where not contra-indicated, 50–250 cc. intravenously of a solution containing 20 per cent calcium chloride and 50 per cent dextrose in physiological saline eased and shortened delivery in cows with a history of protracted labor during previous calvings. There were no cases of milk fever or retained placentae and cows and calves both appeared stronger than is usually the case. S.A.F.

524. Sulfapyridine in the Treatment of Calf Pneumonia. W. T. S. Thorp, J. F. Shigley, and A. K. Anderson, State College, Pa. Jour. Amer. Vet. Med. Assn., *100*, No. 780: 225. March, 1942.

Twenty-four calves, eighteen of which had symptoms of acute bronchopneumonia, were treated with sulfapyridine. Sixteen of the eighteen recovered. Best results were obtained by a high initial dosage and subsequent daily reduction of 0.02 gms. per lb. body weight. There was a significant temperature drop within 24 hours. Recommended initial dosages are 0.05 gms. per lb. body weight for calves up to 70 lbs.; 0.06 gms. per lb. body weight for 70 to 100 lb. calves; and 0.07 gms. per lb. body weight for calves weighing over 100 lbs. divided into three daily doses. Very young calves (less than 2 weeks old) are more susceptible to the drug and should receive smaller doses.

Blood studies on six normal and two pneumonic calves indicate a maximum blood level of 10 mgs. % with an average of 5 to 8 mgs. % is optimum

for calves over two weeks old and an average of from 5 to 6 mgs. per cent for younger calves. Dosage is not proportional to age or body weight.

S.A.F.

525. Further Studies on the Significance of Suspicious Agglutination Reactions for Bang's Disease. C. P. FITCH, W. L. BOYD, MARGARET D. KELLY, AND LUCILLE M. BISHOP, Minn. Agr. Expt. Sta., Jour. Amer. Vet. Med. Assn., *100*, No. 778: 23. Jan., 1942.

Results of twelve years of study on 136 animals are reported. Bacteriological plate cultures and guinea pig inoculations were made at regular intervals of milk, colostrum, placentas and vaginal discharges for the presence of *Br. abortus*. Cultures were also made of various organs of aborted fetuses and of calves which died shortly after birth. Agglutination titre of the blood and milk was determined regularly.

Group I consisted of 39 animals with a 1:25 to 1:50 titre throughout the period except for two animals which later became reactors and shed the organism. Two of 34 negative control animals housed with them became reactors and shed *Br. abortus*. All were removed from the group when their titre reached 1:100.

Group II consisted of a separately housed group of 97 animals entering the herd with titres incomplete at 1:100 or higher. Titres of this group varied from suspicious to positive or lowered to suspicious and remained. *Br. abortus* was isolated from nine of these animals.

It is suggested that, depending on herd history, animals with suspicious reactions may be sufficiently dangerous to warrant their removal from the herd.

S.A.F.

526. A Further Note on the Incidence of *Trichomonas fetus* in Slaughtered Cattle from a Wisconsin Abattoir. B. B. MORGAN AND W. WISNICKY, Univ. Wisc. Jour. Amer. Vet. Med. Assn., *100*, No. 783: 471. June, 1942.

Trichomonas fetus was isolated culturally from two of 997 pregnant uteri, one with a normal, seven months fetus and one with a three months partially macerated fetus. Of 580 nonpregnant uteri, 463 were involuted, 100 had pyometra, 11 had retained placentae and 6 were recent parturitions. Thirteen cases of trichomonad infection were found in the pyometras. No cases were found in 211 bulls examined.

S.A.F.

527. Studies in Ketosis in Dairy Cattle. IV. The Effect of Glucose Therapy and Pasture Feeding in Cases of Clinical Ketosis. J. C. SHAW, R. C. POWELL, JR., AND G. C. WHITE, Storrs Agr. Expt. Sta. Jour. Amer. Vet. Med. Assn., *100*, No. 783: 473. June, 1942.

Case histories of four clinical cases of Acetonemia together with blood and urine studies of ketone bodies, blood sugar and lactic acid levels during

therapy are presented. Frequent administration of considerable quantities of glucose by various routes tended to keep ketones near normal, but did not consistently have a permanent effect. One case recovered when given access to pasture, but this was not consistently true. S.A.F.

528. The Treatment of Chronic Streptococcic Mastitis with Various Bactericidal Agents. RALPH B. LITTLE, Rockefeller Inst. Med. Res., Princeton, N. J. Internatl. Assoc. Milk Dealers Assoc. Bul. *34*, No. 16: 345. 1942.

Seldom does *Streptococcus agalactiae*, the most common cause of mastitis, appear in an acute form. Although usually a cause of the chronic form *Streptococcus dysgalactiae*, *Streptococcus uberis* and others may be responsible for acute forms. A detailed description of methods and equipment used for administering bactericidal agents is given. The acridine derivatives, Entozon, acriflavine, and also trypaflavin were administered by infusion. When an oil solution is injected via the teat canal directly into the milk cistern, advantages in large scale work are smaller volumes of solution, less equipment required and simplification of instrument sterilization. Gramicidin or tyrothricin and Novoxil have been used.

It is emphasized that chemotherapy is a surgical procedure and should be conducted by a veterinarian lest great damage to the udder result from careless technique. A conservative figure for cures in an average herd by means of udder chemotherapy might be below 50% with some herds going as high as 80–90% cures. Mild cases offer the best chance of success and chemotherapy should not be used on acute cases. Injection of tyrothricin and Novoxil may safely be made during the dry period to save on material. Of the bactericidal agents effective against *Streptococcus agalactiae* the author has found the alcoholic solution of gramicidin in sterile water and mineral oil with the dose properly adjusted, was the least irritating and most effective. E.F.G.

529. Studies on the Allergic and Antigenic Activity of Sonic Filtrate of Brucella Abortus. E. L. STUBBS AND I. LIVE, Univ. Pa. Amer. Jour. Vet. Res. *3*, No. 7: 146. April, 1942.

A brief review is made of the literature as regards attempts to produce allergic skin reactions to establish *Brucella* infections. The sonic filtrate was a 72-hour culture of *Br. abortus* concentrated, washed, suspended in saline, exposed to vibrations of audible frequency at 9,000 cycles per second for one to two hours and filtered. Groups of rabbits negative to the agglutination test in dilutions of 1:5 were sensitized by injecting live cultures of *Br. abortus* intravenously and intraperitoneally; phenolized cultures intravenously, and heated but not killed cultures intravenously. Guinea pigs were sensitized by intraperitoneal injections of live cultures. Reaction to

the skin test at 48 and 85 days was nearly 100% in those receiving live cultures and decreased with the degree of attenuation. Intensity of reaction varied with the amount of protein in the injected filtrate. All sensitized animals were positive to agglutination, precipitation, and opsonocytophagic tests. One group of rabbits, sensitized by intracutaneous injections of sonic filtrate, did not react to subsequent skin tests but did react to the agglutination tests. Agglutination titre and the length of time before it disappeared were directly proportional to the amount of protein in the sensitizing injection of sonic filtrate. S.A.F.

FEEDS AND FEEDING

530. Experiments with Annual Crops and Permanent Pastures to Provide Grazing for Dairy Cows in the Sandhill Region of the Southeast. E. W. Faires, J. R. Dawson, J. P. LaMaster, and G. H. Wise. U. S. Dept. Agr. Tech. Bull., *805*. Nov., 1941.

The experiments reported in this bulletin were conducted at the Sandhill Expt. Sta., Columbia, S. C., to determine the extent to which annual crops and permanent pastures could be used to provide grazing for dairy cattle on the light soils of the sandhill region of the Carolinas and Georgia, and to ascertain also the relative economy of these two systems of providing nutrients for milk production. The experiments extended over a five-year period (1933–37) and utilized eight 2-acre grazing plots for the annual crops and a 6-acre pasture for the permanent pasture experiment. Annual crops selected were (1) for winter and early spring grazing, a combination of oats, barley, rye, and vetch, and (2) soybeans and pearl millet for summer and early fall. Other crops given a trial were (1) corn interplanted with velvet beans for fall, (2) crimson clover and Italian rye grass for spring, and (3) pearl millet alone for summer. Seeding mixtures for the permanent pasture were (1) for lowland pasture, common lespedeza, carpet grass, and white Dutch clover; (2) for upland pasture, common lespedeza and Bermuda grass. Dallis grass and hop clover were also used in the lowland.

The permanent pasture, while rather slow in forming a satisfactory sod and with a rather low carrying capacity, furnished nutrients much more cheaply than did any of the annual crops, singly or in combination. It is felt that the returns from the annual crops would have been greater if they had been made into silage instead of being grazed. Least costly annual crop was pearl millet, most costly the combination of rye grass and crimson clover, at $11.87 and $65.89 respectively per ton of alfalfa hay equivalent. On the same basis the permanent pasture cost $8.20 per ton. J.G.A.

531. Feeding and Management of Dairy Calves. C. H. Staples and D. M. Seath. La. Agr. Expt. Sta. Bull., *342*. March, 1942.

Suggestions on the feeding and management of dairy calves and year-

ling heifers based on records of feed cost and growth of 196 Jersey and Holstein calves over a period of eight years (1928–1935) at L.S.U. J.G.A.

532. Dairy Farm Management and Costs in Pennsylvania. W. L. Barr. Pa. Agr. Expt. Sta. Bul., *421*. Feb., 1942.

An analysis of 206 farm records shows that it cost an average of $2.26 to produce and market a hundred pounds of milk from 1938 to 1940, and averaged $2.13, $2.34, and $2.32 for 1938, 1939, and 1940, respectively. Feed and bedding costs averaged about 50%, man labor 30%, and other costs 20% of the gross cost of producing a hundredweight of milk. Returns per hour of labor from the dairy enterprise averaged 35¢ in 1938, 23¢ in 1939 and 29¢ in 1940. Returns to the operators of these farms as measured by labor income were $594 in 1938, $560 in 1939, and $755 in 1940. The important factors responsible for variation in costs and returns were size of business, labor efficiency, and rate of productions. Author's Abstract

533. Profitable Permanent Pastures for Dairy Cattle. D. M. Seath. La. Agr. Expt. Sta. Bull., *341*. March, 1942.

A description of fertilizer experiments with pastures during 1937–40 inclusive in Claiborne, Lincoln, and Washington parishes, La. Reseeding, frequent mowing, and controlled grazing tended to increase the productivity of the pastures from year to year. Annual fertilization accelerated this improvement. Fertilized pastures (350 pounds 4–12–4 in the fall, 50 pounds $NaNO_3$ in May) averaged 58% more cow days of grazing, 64% more milk, and 44% more returns over cost of grain fed and fertilizer used than did unfertilized pastures. Annual returns showed an advantage of $16.05 per acre for the fertilized pastures after deducting feed and fertilizer costs. Yields of air-dry hay from protected areas in the pastures showed a 31% advantage for the fertilized areas and a 24% advantage in phosphorus content of the fertilized hay. Basic slag applied to the previously unfertilized pastures in the fifth year showed a somewhat greater response than was evident that same year from the previously fertilized pastures. Recommendations are given for a definite pasture program based on these results. J.G.A

534. Factors Affecting Profits from Dairy Herds. D. M. Seath and E. W. Neasham. La. Agr. Expt. Sta. Bull., *338*. Feb., 1942.

A study of D.H.I.A. records in Louisiana during 1938–40 inclusive, involving 32 herds in '38, 33 in '39, and 25 in '40. Although it cost more to feed them, high yielding cows returned $2.40 more per $1.00 of increased feed cost than did the low producers. Grain feeding at the rate of 1 pound for each 3.0 to 3.4 pounds of milk proved the most profitable. March to June, inclusive, were the high months both in production per cow and in

average return over feed cost. Of two herds of comparable breeding, the one provided with better roughage over a two-year period, showed an increase of a gallon of milk per cow daily and $71.04 greater return over feed cost per cow yearly. Recommendations based on the findings are given relative to breeding, culling, record keeping, and pasture production.

J.G.A.

535. The Effect of Feeding Some Fat-Soluble Dyes to Milking Cows upon the Color of the Milk Fat. C. F. HUFFMAN AND C. W. DUNCAN, Mich. Agr. Expt. Sta. Quarterly Bull., *24*, No. 1: 54–55. Aug., 1941.

In studying the effect of different fats on milk and fat production the authors were interested in following food fat through the digestive tract and into the milk. For this purpose five different fat-soluble dyes were fed, viz.: Sudan III, Sudan IV, Brilliant Green, Perfect Purple, and Nigrosine Black. The dyes were mixed with 0.5 pound of crude soybean oil with the exception of the Sudan IV which was mixed with solvent-extracted soybean oil meal. The dosage was 15 grams of dye all fed in one feed, except in case of Nigrosine Black where the dose was 45 grams.

It is apparent that milk fat is readily stained by feeding these dyes. Earliest appearance of the dye in the milk fat was in the case of either Sudan III or Sudan IV, where it appeared in the next milking 12 hours later, and persisted for 144 hours. Some of the dyes were evidently altered in their passage through the cows' systems; for example, Perfect Purple produced a green-colored butterfat, and Nigrosine Black a pink butterfat. Either Sudan III or Sudan IV appears to be preferable for this purpose to the other dyes used. J.G.A.

536. A Cobalt Deficiency Observed in Some Michigan Dairy Cattle. A. C. BALTZER, B. J. KILLHAM, C. W. DUNCAN, AND C. F. HUFFMAN, Mich. Agr. Expt. Sta. Quarterly Bull., *24*, No. 1: 68–70. Aug., 1941.

In a study of the disease of dairy cattle colloquially known as "Grand Traverse or Lake Shore Disease" and recognized in Michigan for many years, clinical evidence was obtained which indicated that the condition is essentially due to cobalt deficiency. The blood of affected animals showed a very low concentration of hemoglobin; evidence of ketosis or phosphorus deficiency was lacking. The animals responded very quickly in appetite and vigor to the feeding of a cobalt supplement (either chloride or sulphate) although hemoglobin regeneration was slow. Preliminary investigation showed that the cobalt content of hay grown on affected farms is much lower than hay grown on farms in unaffected areas. J.G.A.

537. The Effect of a High Vitamin A Intake on the Blood and Milk Carotene of Holstein and Guernsey Cows. H. J. DEUEL, JR., L. F. HALLMAN, C. JOHNSTON AND F. MATTSON, Dept. Biochem., Univ. Southern California, Los Angeles. Jour. Nutr., *23*, No. 6: 567. June, 1942.

The cause of the depression of carotene in milk upon the addition of vitamin A to the ration was investigated, using 25 Guernsey cows in one experiment and 26 Holsteins in a second experiment. In each experiment the cows were divided into three groups: group one received 30 ml. of shark liver oil which furnished 700,000 I.U. of vitamin A per cow per day; a second group received an equal amount of vitamin A as a concentrate assaying 545,000 I.U. per gram; a third group were used as controls. In the second experiment, the group of Holstein cows which received the vitamin A concentrate were fed different levels of vitamin A.

The decrease in milk carotene appeared to be caused by the vitamin A *per se*. A constant decrease in blood carotene was also observed when the milk carotene was lowered. Approximately 4 weeks were required for the maximum lowering in carotene to develop while 7 to 10 weeks were required after the cessation of the vitamin A supplement for the return of carotene secretion to normal.

The average increase in vitamin A was 47 units per gram of butterfat for 1,000,000 I.U. The maximum level of vitamin A observed was 331 I.U. per gram. About 3 per cent of the ingested vitamin A was recovered in the milk. C.F.H.

ICE CREAM

538. Substituting for Coconut Fat in Dipping Chocolate. J. J. SHEURING AND P. H. TRACY, Univ. Ill., Urbana. Ice Cream Field, *39*, No. 6: 28. June, 1942.

Difficulty in obtaining coconut oil as a substitute for cocoa butter in chocolate coatings, extensively used in the ice cream industry, prompted the authors to try other fats for this purpose. They give the following as characteristics of good chocolate coating:

(1) Pleasant flavor without waxy after effect in the mouth, (2) firm body when cooled but not brittle enough to fall off ice cream bars while being consumed, (3) resistant to melting at room temperatures, (4) rapid solidification when cooled on ice cream bars, (5) resistant to thickening when moisture is absorbed during dipping, (6) good dipping coverage at 100° to 110° F., and (7) uniform chocolate color.

Experiments were conducted in which soybean oil, hydrogenated soybean oil, coso oil, beef fat, hydrogenated cottonseed oil and corn oil were used as substitutes for coconut oil. Samples were prepared by diluting coating with 8 to 25% of domestic oils and fats, and compared with a standard milk

chocolate coating as a control. "The results indicate that 8 to 15% of low melting point fats and 10 to 25% of high melting point fats can be used successfully as substitutes for coconut oil. The best product was made by using a combination of 5% added hydrogenated soybean oil and 5% soybean oil."

They also state that using 10% cocoa, 40% powdered sugar, 35% hydrogenated soybean oil and 15% soybean oil could be used as a satisfactory coating for emergency use although it was not as desirable as one prepared from chocolate liquor. W.C.C.

539. The Case for the Soda Fountain. L. G. BLESSING, Pres. of Bastian Blessing Co. Ice Cream Field, *39*, No. 5: 14. May, 1942.

The author quotes Joseph J. Hammer, attorney for the New York State Pharmaceutical Association, as stating that the soda fountain is an undesirable intruder in the retail pharmacy and that the fountain-luncheonette is "on the way out." Statements and figures are then presented by the author to show that instead, the soda fountain is "on the way up."

According to the author, reports of the U. S. Department of Commerce show that in the United States in 1929 there were 34,844 drug stores with fountains and 23,414 without fountains. During the period 1929 to 1933 the number of drug stores with fountains increased to 38,448, while 3,455 stores without fountains either failed or voluntarily discontinued business. During the entire period 1929 to 1939 the reports show an increase of 13.2 per cent in the number of drug stores with fountains and a decrease of 21.2 per cent in the number of stores without fountains.

The author concludes that during prosperity and depression a soda fountain makes a druggist's investment safer and more profitable than it would be without one. W.C.C.

540. Testing Ice Cream for Fat by the Pennsylvania Method. W. D. SWOPE, Pa. State College, State College, Pa. Ice Cream Field, *39*, No. 5: 16. May, 1942.

According to the author approximately 3,000 carefully controlled tests were made during a ten-year period to find reagents which would prevent carbonization of added sugar, give a clear fat column, and upon centrifuging, completely liberate fat from dairy products containing chocolate or added sugar. The approved Mojonnier method was used as a comparison for all of these tests.

The Pennsylvania method has been developed as a result of these tests. It makes use of regular Babcock test equipment and reagents that are readily obtainable from chemical supply houses. The reagents are: (1) ammonium hydroxide, 28 to 29 per cent NH_3, (2) normal butyl alcohol, b. p. 117° C., (3) diluted sulphuric acid, specific gravity approximately 1.72 to 1.74.

Details of preparing the samples and the procedure to follow in testing are given.

Tabulations of results obtained by this method show them to be in very good agreement with the approved Mojonnier method. It is concluded that the Pennsylvania method is well adapted for determining the percentage of fat in ice-cream mix as well as ice cream of all flavors. It is stated further that comparable results can be obtained by different operators.

Information regarding the testing of other dairy products by this method may be found in Pennsylvania Agricultural Experiment Station Bulletin 412. W.C.C.

541. 1941 Ice Cream Sales Hit All-Time High. O'NEAL M. JOHNSON, Statistical and Accounting Bur. Ice Cream Trade Jour., *38*, No. 5: 19. May, 1942.

Ice cream sales hit a new high in 1941. The percentage of gain, based on reports from 773 manufacturers, was 18.27%. Increases by period were January–April, 21.05%, May–August, 17.22%, and September–December, 20.75%. December, 1941, was the fifteenth consecutive month in which the nation showed increased ice cream sales over the corresponding month of the previous year. By sections, the North Atlantic Area had an increase of 18.62% for the year, Central East Area, 17.94%, Middlewest Area, 15.84%, Southern Area, 26.29%, and the Western Area an increase of 9.97%. Arizona and New Mexico were the only states not showing an increase. Part of the Southern Area increase was due to a concentration of army camps in that region. Temperatures for 1941 were exceptionally favorable except during February and March. W.H.M.

542. Sugar and Sherbets in Wartime. R. I. MASUROVSKY, Res. Ed. Ice Cream Trade Jour., *38*, No. 5: 32. 1942.

Sherbets are more important to the dairy industry now than they were in the first World War. Many manufacturers are decreasing the sugar content of their ice cream mix one or two per cent and the sherbet mix may be done likewise without serious ill effects. Corn sweetness or invert sugar should be used in combination with cane sugar in sherbets and the numbers of flavors offered should be reduced to two or three. W.H.M.

543. A Neglected Phase of Frozen Desserts Sanitation. F. W. FABIAN, Res. Prof. of Bact., Mich. State Col., East Lansing, Mich. Jour. Milk Technol., *5*, No. 2: 106. Mar.–Apr., 1942.

Next to milk, frozen desserts are the important cause of epidemics.

The ingredients, such as coloring material, flavoring extracts, fruits and nuts, going into the mix after pasteurization should be given a germicidal treatment equivalent to pasteurization. Treatments for so doing are discussed. L.H.B.

MILK

544. How Methods and Promptness of Cooling Affects the Quality of Milk. A. J. Gelpi, C. S. McCleskey and D. M. Seath. La. State Univ. Bull., *344*. 1942.

Comparisons were made between milk cooled in 10-gallon cans in a motor-stirred water tank (33°–40° F.) that cooled on a surface tubular cooler followed by holding in milk cans in 33° to 40° F. water, and that cooled on a conical cooler followed by holding in milk cans in 33° to 40° F. water.

Slightly higher bacterial counts were obtained in the milk cooled in cans. Delayed cooling (2 hours) did not materially affect the quality of the milk when it was cooled over a tubular or conical cooler. When the subsequent cooling was done in the milk can a significant increase in count after holding 12 hours resulted from the delayed cooling.

There was no significant difference in the flavor of the milks cooled by the three different methods.

Can cooling in an over-loaded cooling tank was the least effective cooling method studied. P.H.T.

545. Supply Responses in Milk Production in Southeastern Minnesota. E. G. Strand and E. Hole. U. S. Dept. Agr.,Technical Bull., *798*. 1941.

The primary purpose of this bulletin was the determination some years in advance of a long-time supply schedule for butter fat in an area composed of five counties in southeastern Minnesota. Past trends in production were analyzed for the area as a whole and estimates were formulated of the future production of the area in three possible future price situations: (A) a continuation of 1935 normal prices; (B) a 20% increase in butterfat prices; and (C) a 20% decrease in butterfat prices.

Briefly the changes that occurred in the area from 1927 to 1938 were as follows: butter-fat production apparently increased about 12%, due to a corresponding increase in number of cows. Feed producing capacity was increased 13%. Due to drouth and the A.A.A. program hog production was drastically reduced in 1934, but later the trend was distinctly upward again. Since 1935 production of beef cattle has tended to increase. Poultry and sheep have tended to increase during the entire period. Reduction in number of horses has continued.

Assuming continuation of the normalized prices prevailing in this area in 1935 (situation A), the normal production of butterfat in the area will be 9% higher in 1945 than it was in 1935.

Assuming an increase in the relative price of butterfat (situation B), some transfer of resources from hogs and poultry to dairy cattle may be expected. However, dairying is not sufficiently superior on many farms to warrant more than a moderate increase in it at the expense of other enterprises.

Assuming a relative decline in butterfat prices (situation C) its production is expected to be slightly less than the normal output in 1935. This contraction would be relatively larger than the estimated expansion under situation A.

Comparisons with areas in New England and Wisconsin indicate that responses in dairy production are influenced by alternative enterprises and by changes within the dairy enterprise itself. J.G.A.

546. Technical Control of High-Temperature, Short-Time Equipment. D. M. ROGER, Borden's Farm Products, Brooklyn, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 17: 376. 1942.

In checking the holding time of a STHT unit it is recommended that a cross check be made by two methods, one the conductivity method and the other a calculated holding time based upon the capacity of the holding tube in quarts per second. The calculated holding time will fall upon a straight line graph and the nearer the conductivity results fall on a straight line parallel to it the more reliable they are. Deviations from a straight line by more than .5 seconds should be regarded with suspicion. E.F.G.

547. Experimental Work on Deaeration of Milk. P. F. SHARP, D. B. HAND AND E. S. GUTHRIE, Cornell Univ., Ithaca, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 17: 365. 1942.

The defect, oxidized flavor, in milk can in general be prevented by deaeration of the milk and by bottom up filling to prevent reincorporation of air so that the final product contains below 0.4 to 0.5 mgs. of oxygen per liter.

Data on summer milk as received at New York City pasteurizing plants indicates 13 mgs. of reduced and 4.5 mgs. of dehydro ascorbic acid and 9.5 mgs. of oxygen per liter. Oxidation of the ascorbic acid is hastened by copper contamination in country milk plants. Morning's milk received at the country plants contained 20.4 mgs. of reduced and 0.5 mgs. of dehydro ascorbic acid per liter and night's milk 18.8 mgs. and 1.5 mgs. respectively. Hand milking introduced more oxygen than machine milking, the averages being 5.8 and 4.7 mgs. respectively.

Streptococcus lactis activity sufficient to produce 0.05% developed acidity was necessary to retard oxidation of reduced ascorbic acid. It is thought by the authors that retardation of oxidized flavor by bacteria may be due to factors other than removal of oxygen. Extensive tabular data support the above points. E.F.G.

548. First Annual Producers' Meeting—Introductory Remarks. R. C. ROUCHE, Telling-Belle Vernon Co., Cleveland, O. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 19: 401. May, 1942.

A sample producers meeting is reproduced. These meetings are for the purpose of discussing producers timely subjects. In this sample meet-

ing an address is given by J. C. Nisbet, Extension Director of the Am. Jersey Cattle Club on the subject "Efficient Milk Production" and an Ohio 4-H Calf Club demonstration on the care and handling of a milking machine. Specific directions and a suggested hour to hour program are given for such a producers meeting. E.F.G.

549. Are Standard Costs Practical in Our Industry? W. T. GRANLUND, White Bros. Milk Co., Inc., No. Quincy, Mass. Internatl. Assoc. Milk Dealers, Assoc. Bull., *34*, No. 18: 395. 1942.

Since standard costs furnish performance goals the effect of the use of this system upon efficiency is important. The standard cost system is divided into (1) City Plant, (2) Containers, (3) Selling and Delivering. The above items are further broken down. Each month a variance sheet shows the difference between actual cost and that of the standard cost system. E.F.G.

550. Can Operating Costs be Reduced by the Use of Multiple Containers? CHARLES A. ARMITAGE, United Farmers Cooperative Creamery Assoc., Inc., Boston, Mass. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 18: 387. 1942.

Summing up the plant savings which can be made in putting out milk in two-quart rather than one-quart bottles the conclusion is reached that this amounts to about one-quarter of a cent per quart or a total saving of one-half cent on the two-quart container. The general statement is made that the saving in delivery should be much greater than in plant operation but no figures are given. E.F.G.

551. Methods for Compensating Routemen when Routes are Split. SAMUEL GAILEY, Supplee-Wills-Jones Milk Co., Philadelphia, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 18: 383. 1942.

An equitable formula in compensating a routeman when his route is split should give consideration to the following factors: 1. Present method of compensation—A basic weekly wage will not be reduced but commissions will be. 2. Stabilization of the earnings of the routeman. Compensating for commissions until these can be built up again. 3. Reasonable cost to the company. So that new business will not be too costly.

The following formula has been included in union agreements and has been found practicable from the standpoint of labor and management. "When a route is split, the routeman shall receive in addition to the amount actually earned on such route as split for the first week after the split, an amount equal to the weekly loss in commissions due to the split. Thereafter this amount shall be progressively reduced each succeeding week by an amount obtained by dividing such weekly loss in commissions due to the split by one-half of the number of quarts lost due to the split." Such pro-

gressive weekly reduction is to continue until the amount equal to the weekly loss due to commissions due to the split has been exhausted. The "weekly loss in commissions due to the split" is the weekly commission on the average weekly sales to the customers taken from the route for four weeks prior to the split; and the number of quarts lost due to the split "is the average daily number of quarts delivered to such customers during such four-week period." The above is based upon keeping the routeman's compensation level by the acquisition of two quarts of new business per week. E.F.G.

552. Effect of Water Bacteria on Quality of Dairy Products. W. B. SARLES Univ. Wis., Madison. Natl. Butter and Cheese Jour., *33*, No. 7: 14. July, 1942.

Bacteria from air, soil and sewage may contaminate water; for use in a dairy plant water must be free of sewage pollution and should contain very few bacteria of air or soil origin. Water from cooling tanks or water used for rinsing equipment may get into milk; washing buttermilk from butter illustrates how water may contaminate a manufactured product. Waterborne contamination may cause May apple flavor, rancid, putrid, cheesy, or unclean flavors and gassiness in milk or cream held at 32° to 50° F. for more than one day; similar defects may be expected in bulk evaporated milk stored at 32° to 45° F. for several days. Water bacteria in butter may cause May apple flavor, rancid, potato, cheesy, skunk and putrid flavors; churns or equipment may be carriers of such bacteria. Water bacteria may cause gas or bitter flavors in cheese. The bacteriological quality of the water supply should be determined frequently; pasteurization or chlorine disinfection should be used when necessary for water that may contaminate the equipment or products. W.V.P.

553. Detecting Bloody Milk. H. J. BRUECKNER, Cornell Univ., Ithaca, N. Y. Am. Milk Rev., *3*, No. 11: 260–261. 1941.

Bloody milk may be detected by allowing the first few streams to flow over a piece of black bakelite, on which it appears to have a pink color. If a half pint is held 12 hours the cream layer may show the presence of blood. Or the first few streams of suspected milk may be placed on filter paper, a few grains of powdered benzidine added, followed by a few drops of glacial acetic acid, and 4 to 6 drops of hydrogen peroxide. A positive test is indicated by a blue to green discoloration. P.S.L.

554. Flexible Prices for Milk. LELAND SPENCER, Cornell Univ., Ithaca, N. Y. Am. Milk Rev., *4*, No. 1: 10–11. 1942.

Determination of a just price and delay in adjustment to changing conditions are two major difficulties in fixing milk prices. The latter difficulty may be solved by adoption of a formula for setting the price. A few objec-

tions to prices set by production costs are purchasing power of consumers and competition from other buyers of milk. Judgment must be exercised, depending upon the quotations upon which the formulae are based and unusual conditions such as drought. P.S.L.

555. Homogenization of Milk to Prevent Excessive Fat Rising. H. J. BRUECKNER, Cornell Univ., Ithaca, N. Y. Am. Milk Rev., *3*, No. 10: 235–236. 1941.

No advantage was found in using two-stage homogenization to prevent fat rising. A pressure of 3000 pounds was necessary with the single stage at pasteurizing temperature, and produced milk meeting the standard of the American Public Health Service. If milk below the upper hundred ml. portion tests 4%, that in the upper one hundred ml. layer must test no more than 4.2%, or 5% greater than the body of the milk, after 48 hours storage. P.S.L.

556. Factors in Price Determination. LELAND SPENCER, Cornell Univ., Ithaca, N. Y. Am. Milk Rev., *4*, No. 1: 16–17. 1942.

The Federal Marketing Agreement Act of 1937 set up parity of purchasing power as the major consideration in setting milk prices, although under certain conditions this consideration may be set aside entirely. Reliable statistical data as to demand, supply, and price levels, are essential for sound price making, and they must be utilized intelligently in forecasting conditions. Each factor must be weighted to judge its relative value. Examples from the New York market are given to illustrate those changing factors that must be given consideration in arriving at as near just prices as possible. P.S.L.

557. Minnesota Babcock Test Reagent. S. T. COULTER, Univ. Minn., Minneapolis. Am. Butter Rev., *3*, No. 8: 282. 1941.

Minnesota reagent has proved satisfactory for use in schools where danger from acid is a factor, but is not advised in states not recognizing the test in the buying of milk and cream. It has proved very satisfactory for the testing of ice cream and condensed milks in laboratory control but has not been considered an official test. For buttermilk testing it has given results that may be duplicated. P.S.L.

558. Effective Can Washing. V. SCHWARTZKOPF, Lathrop-Paulson Co., Chicago, Ill. Am. Butter Rev., *4*, No. 1: 10–16. 1942.

A complete resume of results secured in several plants through use of Mikro San acid for can washing is given. A cleaner and more nearly sterile can was secured through its use due to atomization of the cleaner, use of

clean wash water, removal of solids from wash water, high temperature wash water, longer exposure to heat, rapid drying, prevention of stone formation, and keeping the can on the neutral or acid side. The cleaner reduced greatly the thermophylic, thermoduric, lipolytic, and proteolytic types of bacteria. It reduced steam costs 30 to 60%, feed water 50 to 75%, detergent 70%, and required less labor. Other benefits from the use of a cleaner of acid reaction were listed. P.S.L.

559. **Symposium: Opportunities for Reducing Operating Cost. (A) Butterfat Cost.** F. BRUCE BALDWIN, JR., Baldwin Dairies, Inc., Philadelphia, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 15: 325–330. Feb., 1942.

The butterfat method of accounting for milk plant losses is suggested as the most accurate. Losses beyond 2% are considered excessive. By a record of weights of milk and cream used by each department, drip sampling on flow lines and by vat sampling it is possible to locate the department in which losses occur. Affecting the accuracy of a fat accounting system are (1) accuracies of counting by plant men, (2) accuracy of tests, (3) suitable conversion factors. Conversion factors appropriate to the temperatures actually used should be employed. E.F.G.

560. **Symposium: Opportunities for Reducing Operating Cost. (B) Plant Cost.** J. F. MALONE, Borden-Wieland, Chicago, Ill. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 15: 331–336. Feb. 1942.

More than 90% of all milk plant operating costs are made up of the following: labor, property expense, caps, cartons, parchment, repairs to buildings and equipment, product waste, fuel, electricity, bottle breakage, washing powder, and water. Labor represents about 50% of all plant costs and should be broken down by operations so that excessive amounts of labor or variations in requirements will be evident by noting the labor requirements per unit of product. Accurate figures on usage for various supplies will disclose when current consumption is excessive. E.F.G.

561. **Public Health Aspects of Reciprocal Inspection of Milk and Cream Supplies.** GEORGE W. GRIM, Ardmore, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 14: 319–322. Feb., 1942.

The primary responsibility for enforcing requirements "looking to the promotion of quality sanitation and decency in practices prevailing upon dairy farms producing milk afterwards to be pasteurized rightfully belongs to the buyer of milk, not to the Health Department. The Health Department of the state or city should be expected to assume the most active

official supervision which at all times should be secondary to the control and supervision of the buyer." The Health Department discharges its major responsibility which is protection of health when it assures supervision of effective pasteurization. Needless duplication of inspection of dairy farms could be eliminated by fairly uniform rules and regulations together with reciprocal arrangements. The details of regulations with reference to quality should come from buyer suggestions. E.F.G.

562. Reciprocity Inspection of Milk and Cream Supplies. TOM G. STITTS, U. S. Dept. Agr., Washington, D. C. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 14: 313–318. Feb., 1942.

Reciprocity in general is "The full acceptance by each of two or more milk inspection authorities of the inspection and certification of each other." Four types of reciprocity are: 1. Between plants in the same milkshed; 2. Between cities receiving milk from the same milkshed; 3. Between separate milksheds; 4. Between widely separated milksheds.

Although the first two are clearly advisable, real difference of opinion exists with regard to the last two. Technical, economic and political factors are involved. It is contended that although the lack of reciprocity has been to raise milk and cream prices this rise has been negligible. It is stated that reciprocity between milksheds would discriminate against local milk dealers and favor the development of national and regional chain-dealer organizations. A marked loss of bargaining power by local producer cooperatives would resul' in a trend to larger cooperatives. Changes will undoubtedly come involving simplification and standardization, but the desire of the public for fresh milk and their confidence in the inspection service under which it is produced are important considerations. E.F.G.

563. New Areas of Supply and Demand. J. L. DAVIES. Milk Indus., *24*, No. 10: 23. 1942.

Taking the total sales of milk in 1941, consumption in Great Britain as a whole was about twenty-five per cent higher than in the pre-war period. The increase was greatest in the North and while milk travelled South in large quantities before the war, the movement in 1941 was the other way. The greatest increase in consumption was by families with the lower incomes per head.

Following the great increase in consumption of milk, it has been necessary to draw supplies of liquid milk from the more remote parts of the country. A high proportion of this milk is produced on small farms where there are inadequate facilities for cooling and preparing the milk for the liquid market, resulting in difficulties through souring.

The most important change, perhaps, is the increase in the number of small producers since 1939. No less than 25,000 farms, mostly small, have

placed their milk on the market for the first time. About half the total of 150,000 producers have less than twelve cows. Only about 25,000 farms are accredited. J.J.S.

564. Turn Off the Heat. ANONYMOUS. Natl. Butter and Cheese Jour., *33*, No. 5: 12. May, 1942.

It is essential for quality control and economy that milk and cream should be cooled promptly and to a low temperature. Common methods are described and a U. S. Geological Survey map of the United States is given showing well-water temperatures at 30 to 60 ft. depths. W.V.P.

PHYSIOLOGY

565. Clinical Observations on the Use of Equine Gonadotropin in the Mare and Cow. H. S. CAMERON, Univ. Calif. Jour. Amer. Vet. Med. Assn., *100*, No. 778: 60. Jan., 1942.

"Nine mares and 46 cows were treated with equine gonadotropin in an attempt to induce estrus where the cycle was dormant. All of the mares responded within ten days, whereas 25 cows failed to respond. Judging from the results, the hormone was highly effective in mares, considerably less effective in cows." S.A.F.

566. Increase in Weight of Gonads Following Injection of Single Male Rat Pituitary. R. P. REECE AND E. J. WEATHERBY, N. J. Agr. Expt. Sta. Proc. Soc. Expt. Biol. and Med., *49*, No. 2: 218. Feb., 1942.

Pituitary glands were collected from 80 sexually mature male rats and injected into eighty 24- to 26-day-old female rats. Injections were made subcutaneously twice daily for 4 days and the recipients killed 100 hours after the first injection and the ovaries weighed. For controls the ovaries of fifty-seven 28- to 30-day-old non-injected rats were weighed. Average ovarian weight of the control animals was 13.4 mg. whereas that of the injected animals was 54.8 mg. Sixteen similar pituitary glands were injected into 16 one-day-old male white Leghorn chicks and the testes weighed 100 hours after the first injection. Thirty chicks receiving no treatment served as controls. Average testicular weights of the control and of the injected chicks were 9.5 mg. and 15.4 mg. respectively. R.P.R.

567. Effect of Estrone on Lactogen Content in Pituitary and Blood of Male Rabbits. JOSEPH MEITES AND C. W. TURNER, Univ. Mo. Proc. Soc. Expt. Biol. and Med., *49*, No. 2: 190. Feb., 1942.

Three groups of male New Zealand White rabbits were injected with 3 different levels of estrone and a fourth group served as controls. Pituitary

assays revealed that a considerable increase in lactogen content was obtained, although a dosage of 5000 I.U. of estrone produced a smaller increase than did either 500 or 1000 I.U. Assays of whole untreated rabbit blood showed that a definite increase in the release of lactogen into the blood was secured following estrone injection. R.P.R.

568. Role of Estrogen in the Stimulation of Mammary Lobule-Alveolar Growth by Progesteron and by the Mammogenic Lobule-Alveolar Growth Factor of the Anterior Pituitary. JOHN P. MIXNER AND CHARLES W. TURNER, Univ. Mo. Endocrinol., *30*, No. 2: 591. April, 1942.

The range of dosage which would best synergize with 1 mg. of progesterone in stimulating mammary lobule-alveolar growth in the ovariectomized virgin mouse was found to be quite wide; however, a dosage of 100 I.U. was found to be optimal. When progesterone was injected alone approximately 6 times as much was required to obtain the same degree of alveolar growth as when estrone was simultaneously administered. Estrone also markedly enhanced the ability of pituitary material to elicit alveolar growth. Estrone in large amounts inhibited the activity of progesterone on the mammary glands but did not inhibit the activity of pituitary materials. It was found that estradiol benzoate and diethylstilbestrol could be substituted for estrone as a synergist with progesterone to induce mammary lobule-alveolar growth. R.P.R.

569. Growth of the Male Guinea Pig Mammary Gland with Diethylstilbestrol. A. A. LEWIS AND C. W. TURNER, Univ. Mo. Endocrinol., *30*, No. 4: 585. April, 1942.

Groups of 3 to 5 male guinea pigs were injected subcutaneously daily with 0.01 to 50 micrograms of diethylstilbestrol. No obvious signs of main duct growth were apparent; however, some extension of the duct system appeared to have occurred at dose levels of 0.1 microgram and above. Lobule growth occurred in all groups showing duct extension. The early formed lobules contained no alveoli but when developed further alveoli were numerous. The development of male mammary glands did not compare favorably with that secured in a single treated female. Secretion was not observed in the male glands with alveoli. The teats of male guinea pigs in all groups were larger than those of the controls. Doses of diethylstilbestrol higher than 0.1 microgram caused no greater growth than did 0.1 microgram. R.P.R.

MISCELLANEOUS

570. The Treatment and Disposal of Waste Waters from Dairies and Milk Products Factories. Technical Paper No. 8. Water Pollution Research Board of Great Britain, His Majesty's Stationery

Office, London. (In U. S. A. can be obtained at British Library of Information, 30 Rockefeller Plaza, N. Y.)

The publication of this investigation on the disposal of dairy wastes will be welcomed in this country as much as in Great Britain where the work was conducted. Some years ago the Water Pollution Research Board was faced with the problem of devising a satisfactory method of purifying the polluting waste washing waters from dairy plants. An intensive investigation was initiated which covered a period of seven years. The experiments made, and the results obtained, with the conclusions and recommendations derived from them, are described in this report. These results should give confidence and direction to anyone confronted with the dairy waste problem, since a practical and economical method of waste treatment has now been designed for the special needs of our industry.

In reading the report one is impressed with the scope and thoroughness of the investigation. Two factors skillfully attended to in planning the investigation were no doubt responsible for the success attained in studying and appraising the various waste purifying processes. First, the investigation was conducted by a well-organized "corps of experts" including several engineers, chemists and biologists. Secondly, after preliminary laboratory and small-scale experiments, two experimental plants for work on a commercial scale were installed at a United Dairies milk and cheese plant. One treatment plant consisted of two percolating filters, each 25 feet in diameter, while the other plant was designed for treatment of milk effluents by the activated sludge process with aeration by bubbles of air passed through diffusers. The functioning of these plants was carefully studied for three years, and the results furnish much of the evidence presented in the report.

The results of the investigation showed that dairy wastes could be most satisfactorily purified by treatment in two percolating filters in series, with periodic change in the order of the two filters. By this method final effluents of high quality were obtained.

In general, satisfactory treatment of milk wastes by the activated sludge process was more difficult to control and the process was somewhat easily upset by flushes of liquid of abnormally high strength.

Plans, drawn to scale, of the double filtration plant and the activated sludge plant are included in the bulletin. There is a section devoted to a study of the organisms on the surface of the filters and those in the activated sludge. An appendix includes the methods of analysis of crude waste waters and treated effluents, notes on organisms isolated during the investigation and results of tests on the action of dairy waste waters on cement products.

J.H.E.

571. Paint in the Dairy Plant. W. K. HOFFMAN, Pittsburgh Plate Glass Co., Memphis, Tenn. South. Dairy Prod. Jour., *31*, No. 5: 24. May, 1942.

Directions are given for interior painting of dairy plant. White enamel consisting of resin and little or no oil are preferable to those containing substantial amounts of oil. The first type requires a foundation flat white coat for adhesion. One-coat products become yellow upon exposure as the oil which they contain oxidizes.

In cases where gray, black or orange spots of mold, fungus or "mildew" occur, the thorough washing of all surfaces is necessary. Trisodium phosphate or other equally effective compounds should be used. After this, the surfaces must be sterilized with products which liberate available chlorine to prevent the growth of fungus beneath or through the coats of paints which follow. A two-coat fume-resistant finish, free from oils capable of supporting mold growth and containing anti-mold compounds should follow. Strong poisons, such as bi-chloride of mercury should be avoided. It is desirable to apply to the dry painted surface a wash coat of clear fungicide as an added precaution. Application may be made with calcimine brushes or sponges. Such treatment should prevent growth of mold into the paint film, but growth in food deposits upon the surface may occur.

Maintaining paint on concrete floors is a very difficult problem. The presence of moisture beneath the floor and the dusting of concrete cause most failures. Old paint which is peeling should be entirely removed. The use of tri-sodium phosphate cleaning solutions and, if grease or oil is present, free alkali cleaners are recommended. Following thorough washing with clear water, the surface should be etched with a solution of one part of muriatic acid and three parts of water.

The painting of refrigerator pipe lines before peeling and scaling occur is recommended. Paints and primers of the zinc chromate bakelite type are vastly superior to iron oxide or red lead products.

Light-colored paints low in degree of gloss provide the maximum distribution of light and minimum of glare. F.W.B.

572. Trends in Dairying by Major Type-of-Farming Regions. W. F. FINNER AND R. L. MIGHELL, U. S. Dept. Agr., Technical Bull., *751*. Jan., 1941.

The principal purpose of the investigation here reported was to examine recent regional trends in dairying in the major type-of-farming regions of the United States. This was an initial step in a more complete analysis leading to careful estimates of probable long-time supply responses or trends for each region, under each of several possible sets of price relationships.

For many years there has been a marked and fairly continuous upward trend in milk production and in the number of milk cows in the U. S. This

report examines the changes since 1928 by major type-of-farming regions. The Cotton Belt showed the highest rate of increase in number of milk cows from 1928 to 1939; this region, the corn belt, and the dairy region account for about 65 per cent of the total increase in milk production for the period. It is evident that much of the additional milk production in the Cotton Belt and in some of the other regions has been consumed locally, and that much of the increase in the Cotton Belt was on farms with small herds (3 cows or less).

Changes in the agriculture of selected areas have been examined for an explanation of the changes in dairying. In northern Vermont increases in production have been explained on the basis of increases in available feed as a result of improved fertilizer practices on grass and hayland. Dodge County, Wisconsin, also has increased dairy production largely through production of more feed on additional cropland and by growing more legumes. In the south it appears that dairy production is related to shifts out of cotton into feed crops and pasture, to reduction in the number of horses and mules, to the use of cropland not previously in production, and to the establishment of dairy manufacturing plants. J.G.A.

573. Care of Equipment. E. H. FORSTER, Cherry-Burrell Corp., Cedar Rapids, Iowa. Ice Cream Field, *39*, No. 5: 13. May, 1942.

The author considers the following of paramount importance for the proper maintenance of equipment. (1) Definitely assign responsibility for maintenance of each machine. Unless this is done proper lubrication and other necessary operations are not likely to be performed. (2) Inspect machinery at regular intervals. This should be done by one or more experienced and responsible persons. (3) Keep complete accessible file of installation, instruction and maintenance manuals and parts lists. (4) Keep complete file of data contained on name plates of all machines, motors, electrical starting equipment and miscellaneous equipment used. Attach this data to the parts lists. (5) Follow manufacturers, lubrication instructions to the letter. Considerable emphasis is placed on the importance of proper lubrication. (6) Make mechanical adjustments regularly. Do not wait until machine operation is affected. The cause should be determined before attempting major adjustments. (7) Maintain reasonable stock of replacement and repair parts. (8) Know your electrical equipment and get professional help on care and maintenance if necessary. (9) Train plant personnel in habits of careful handling of machine parts and provide equipment that will permit and encourage this practice. (10) Keep machinery properly cleaned.

The author states that machinery manufacturers, aware of the importance of proper maintenance, are helping plant operators and superintendents in the proper maintenance of their machinery. W.C.C.

574. Care of Equipment. A. W. FARRALL, Creamery Package Mfg. Co., Chicago, Ill. Ice Cream Field, *39*, No. 5: 13. May, 1942.

Accompanying the author's discussion are the following "ten commandments": (1) Read the manufacturer's instruction manual. The operator as well as the plan superintendent should do this. (2) Observe a regular lubrication program, using the correct lubricant for the job. (3) Train the operator so that he understands the principle of operation of his machine. Do this before he has done unnecessary damage. (4) Don't drop parts on the floor. Use a rubber or composition mat for supporting washed parts. (5) Don't overload the equipment. (6) Replace worn parts before they actually give out and cause breakage of other parts. (7) Provide good support for sanitary pipe lines. (8) Don't pound sanitary fittings. Use a wrench. (9) Follow the manufacturers' recommendations regarding cleaning procedure. Don't dump washing powder in the bottom of a vat. (10) Keep brine properly neutralized and treated so that it is not corrosive.

Emphasis is placed on proper sterilization by heat or chemicals and brief instructions given in each case. Special instruction is also given for the care of ice cream freezers, homogenizers and refrigeration equipment.

W.C.C.

575. Care of Equipment. GEORGE D. ARMERDING, Mojonnier Brothers Co., Chicago, Ill. Ice Cream Field, *39*, No. 5: 12. May, 1942.

The author gives the following "commandments," and briefly but effectively discusses and illustrates each: (1) Keep equipment clean. (2) Do not abuse your equipment. (3) Lubricate thoroughly and intelligently. (4) Practice regular inspection and prompt repairs. (5) Organize your efforts. (6) Conserve available material. (7) Provide proper tools. (8) Follow instruction manuals. (9) Study available substitutes. (10) Use some common sense.

W.C.C.

576. Distribution: Trucks, Gasoline, and Labor. ARTHUR C. BUTLER, Automobile Mfrs. Assn., Washington, D. C. I. A. I. C. M. Prod. and Lab. Council Proc., p. 69. 1941.

Motor transportation problems in relation to national defense were discussed in this paper. Necessity for maintenance of transportation, heavy and medium trucks, replacement material, priority ratings, and rubber shortage and the problems they involve were explained and emphasized.

P.S.L.

577. Efficient Utilization and Substitutes for Cork. L. E. COVER, Armstrong Cork Co., Lancaster, Pa. I. A. I. C. M. Prod. and Lab. Council Proc., p. 55. 1941.

When cork board was placed on the mandatory priority system in June, 1941, defense requirements were given first consideration and food preser-

vation at temperatures lower than 20° F. given next preferential rating. Allocations for repair and maintenance have been small and vary from month to month. Used with corkboard in truck bodies Temlok and Fiberglas have proved relatively efficient. The same materials may be used in ice cream cabinets and ¾ # density Fiberglas used in such nonstructural pieces as side walls, ends, and tops for cabinets. A method of testing these substitute insulators was described. P.S.L.

578. Chemical Effects in Refrigerating Systems. E. W. McGovern, E. I. duPont de Nemours & Co., Inc., R. & H. Chemicals Dept. Refrig. Engin., *43*, No. 5: 276. 1942.

Factors considered as underlying chemical reactions in refrigerating systems are moisture, air, heat, metals, lubricants, and the refrigerants. Various combinations of these factors may be found in one refrigerating system and not in another. With air and water present as contaminating substances, untoward solvent and chemical effects may follow giving rise to such conditions as corrosion, "sludge" formation, copper transfer, freeze-ups, and gasket failures. In removing moisture, a common mistake made in vacuum treatment is failure to apply a high enough vacuum and to hold it long enough. Drying agents recommended are activated alumina, "Drierite" or silica gel placed in the liquid line. Alkaline drying agents react with halogenated hydrocarbon refrigerants forming chlorides. Calcium oxide should not be employed in moist sulfur dioxide systems, as the rapid reaction between alkali and acid accompanied by evolution of large quantities of heat might give rise to an explosion. Perchlorate drying agents such as magnesium and barium perchlorates, should never be used in refrigerating systems, as serious explosions may result from their contact with lubricating oils or flammable refrigerants. Calcium chloride as a drying agent is undesirable since it may form a water solution which, in passing through the refrigerating system, will bring about corrosion.

To prevent sludging of oil used for lubrication in refrigerating systems, the oil must have high thermal stability and be not subjected to chemical and physical effects of excessive temperature, air drawn into the system, and moisture. Gaskets should be resistant to solvent action of oil and refrigerant as well, and for other than ammonia and sulfur dioxide systems in which rubber may be used, several of the newer products such as neoprene and the polyvinal alcohol plastic are finding use. L.M.D.

579. Fiberglas Insulation in the Low-Temperature Field. John B. Schneller, Equip. Insul. Div., Owens-Corning Fiberglas Corp. Refrig. Engin., *43*, No. 5: 280. 1942.

A description of the new "Fiberglas AE" board for low temperature and roof insulation is given. Research, stimulated by lack of cork imports,

has led to the development of a desirable form of insulation board from the basic material, Fiberglas, one which lends itself to installation methods similar to those which have been in force for cork board. The basic "Fiberglas" offers high resistance to heat transfer, is inorganic, free of odor, does not absorb odor, is incombustible, will not rot, mildew, or offer sustenance to vermin. "AE" board is made of pure glass fibers, compressed to a density of 6 lb. to the cubic foot, and treated with a binder to increase the rigidity of the final product. The core of glass fibers is enclosed in a $\frac{1}{8}$-inch thick sheath of durable asphalt that has a high melting point. Surface treatment consists of white sand, rolled into the asphalt. This provides a good bonding surface and prevents adhesion of the boards to one another in transit or storage. The heat conductivity of the board is 0.265 BTU per sq. ft., per ° F., per inch of thickness at a mean temperature of 60° F. Its moisture absorptive property is in the lower range. It is fire retardant, and is resilient. L.M.D.

580. Opportunities of Reducing Operating Costs. (C) Distribution Cost. V. R. CORRIGAN, Polk Sanitary Milk Co., Indianapolis, Ind. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 15: 337–341. Feb., 1942.

Experience with the six-day delivery plan revealed that construction of more storage space, larger number of bottles needed and other extra expenses nullified any delivery savings during the early stages. Inadequate supply of Grade A milk for Friday processing also presented a problem. Although the six-day plan has merit and should ultimately effect savings, still all angles should be examined and prepared for before adopting it. The loyalty and confidence of the salesmen is the first step in improving distribution efficiency. The "Standard Order Method" reduces the temptation to embezzlement while the added clerical work of the system may be transferred from route salesmen to a clerical force with savings. From the records a "break even point" should be calculated for the route. E.F.G.

581. The Effect of Government Regulation of Retail Credit upon the Dairy Industry. M. M. DOUGLAS, Credit Mgr., Maplehurst Farms, Inc., Indianapolis, Ind. Milk Dealer, *31*, No. 7: 34, 66–70. April, 1942.

The author points out the following facts: We must recognize the existence of an activity of certain forces which, under the guise of patriotism, are trying to reconstruct our national economy to fit their version of an economic Utopia. We must not lose sight of the fact that even though we are at war, there are still pressure groups of various sorts who have axes to grind. Under cover of the confused thinking and hysteria prevailing in times like these, they will try, by vigorous flag waving, to put over a few

fast ones. And some of these individuals are in positions of great authority. The author discusses the effect of government regulation of retail credit upon the dairy industry. The results of the restrictions are summarized as follows: 1. Under every-other-day delivery the driver's opportuity to collect is cut in half. 2. Increased loads due to consolidation of routes, where that has been done, limits the amount of time available for collection. 3. The urgent necessity for conserving rubber prevents the possibility of extra trips to collect. 4. Previously contracted obligations, increasing cost of living, increasing taxes and the necessary purchase of defense bonds and stamps, mean that the customer, defense worker or otherwise, has a much harder time to make the budget balance.

Suggestions offered to overcome these various factors are as follows: First: We can keep our heads—this is no time to become panic-striken or hysterical. Common sense and straight thinking will accomplish many things. Second: We can establish community credit policies and cooperate. There is no competition in credit, so there is no reason why we cannot get together in our individual communities and work for the common good. Carried a step farther, we can work with our fellow dairymen in other cities. Third: We can tighten up our individual policies and keep our accounts as near current as possible. Fourth: Through our national, state and local trade associations, we can make a determined effort to secure representation at any conference or hearing held by the W.P.B. affecting us, directly or indirectly. Fifth: As one of the prime factors in the promotion of national health and economy, we can ask for serious consideration of our representations to the board. C.J.B.

582. Preventive Maintenance on Trucks Pays Dividends. ANONYMOUS. Milk Dealer, *31*, No. 7: 31–32, 60–61. April, 1942.

This article is a discussion of truck maintenance as practiced at the Chestnut Farms-Chevy Chase Dairy, Washington, D. C. A description is given of the daily inspection report on which drivers check items requiring repairs, adjustment, and attention. A copy of the general inspection form containing 53 items which the mechanic must check and okay every 2,500 to 3,000 miles, is shown. Other forms used, such as Trouble call, Wash report, Material requisition, Grease report, Daily electric report, Tire change record, etc., are also discussed. C.J.B.

583. Cleaning and Sterilizing Dairy Plant Equipment. C. M. MOORE, Diversey Corp., Chicago, Ill. Natl. Butter and Cheese Jour., *33*, No. 5: 10. May, 1942.

Use good cleaners properly: Rinse before washing; dismantle and scrub every piece of equipment and rinse with hot water after washing; special treatments may be necessary to remove milkstone. In washing cans, cleaners

should: remove milk deposits, soften the water, keep the machine free of scale but should not remove tin.

Sterilization, the final step in cleaning, may be accomplished with steam or hot water at 180° F. for 2 to 5 minutes or with chlorine sterilizers which can be used effectively and economically even on open surfaces. Chlorine sterilizers containing 100 ppm. of available chlorine can be pumped through pipes, filters and heaters for about 5 minutes while large tanks and open surfaces are best sterilized by spraying with a 250 ppm. solution. Detailed instructions are given for each cleaning and sterilizing operation with special precautions for some equipment. W.V.P.

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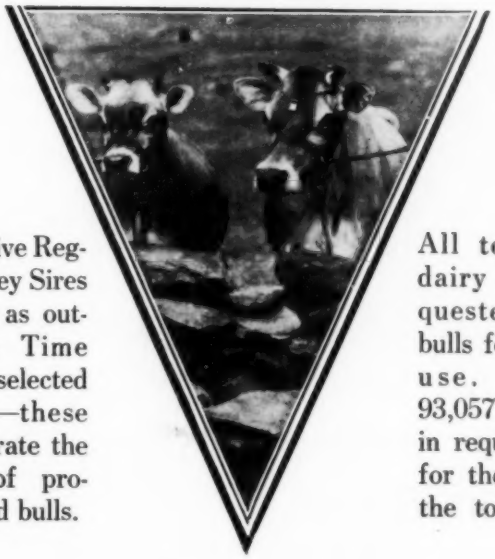

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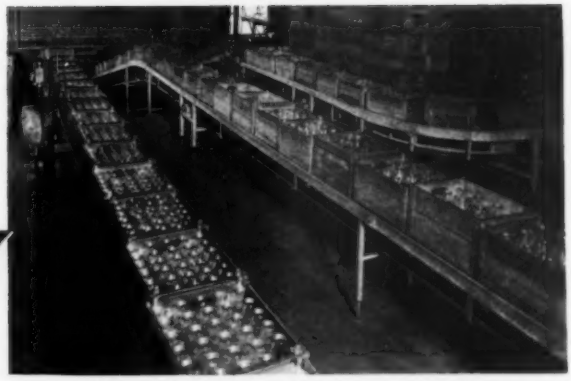

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TODAY, with dairy production geared higher than ever before, it has become vitally important to eliminate waste motion in the plant. Manual handling of cases and cans, for example, mean not only increased costs, but loss of valuable man-hours that could have been used in productive efforts. Dairymen have found Mojonnier Power Conveyors the ideal answer to their plant transportation problems. Handling costs are lowered—top efficiency is effected by a smooth flow of continuous production and by coordination of inter-department work.

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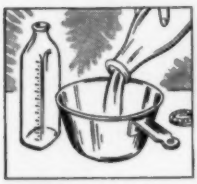
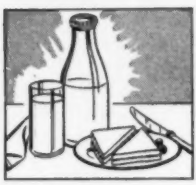
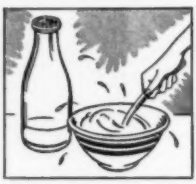


BABY'S FORMULA: Pure milk guarded against danger of contamination by Seal-Kap.

BREAKFAST: Bottle opened. Seal-Kap *re-seals*, completely covering the pouring lip.



LUNCH: Bottle opened again. Seal-Kap still on guard against dirt, dust and ice-box odors.



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Both embody the famous CP Film-Heat method of protecting flavor and insuring maximum cream line. Positive pump circulation is standard on the Pacemaker, extra on the Model "B." Very satisfactory heating time is secured with water at 160°F. or less.

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is recommended in "Standard Methods for the Examination of Dairy Products" of the American Public Health Association for direct plate counts of coliform bacteria in milk and other dairy products. Upon plates of medium prepared from Bacto-Violet Red Bile Agar coliform organisms form reddish colonies, 1 to 2 mm. in diameter, which are usually surrounded by a reddish zone of precipitated bile. After incubation for 18 hours at 37°C. counts of these colonies may be made without interference by extraneous forms.

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is an excellent medium for detection of the presence of coliform bacteria in milk. Results obtained by direct inoculation of milk into fermentation tubes of medium prepared from Bacto-Brilliant Green Bile 2% are a dependable indication of the presence of coliform organisms in the original sample. Use of this dehydrated medium is approved in "Standard Methods."

BACTO-FORMATE RICINOLEATE BROTH

is also a useful medium for detection of coliform organisms in milk. The medium is used in fermentation tubes which are inoculated with the milk sample. Growth of lactose fermenting bacteria is stimulated and gas production is accelerated in this medium. Use of the dehydrated medium is approved in "Standard Methods."

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